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CONTENTS

Page

Dr. G. Schumacher:

Control of Yellows Occurring on Sugar Beets in Rhineland 153

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BAYER LEVERKUSEN (GERMANY)
Department for Plant Protection

Control of Yellows Occurring on Sugar Beets in Rhineland

(Report on tests and control carried out in 1952 and 1953)

by Dr. G. Schumacher

Plant Protection Office, Bonn (Chamber of Agriculture Rhineland)

CONTENTS

Page

Introduction 153
I. Large-scale test 1952 154
1. Problems 154
2. Test area 156
3. Fertilization 158
4. Sprays 159
5. Observations on the overwintering of the vector and the yellows virus 161
6. Population movement of *Myzodes persicae* and *Doralis fabae* 161
a) Population movement in the check plots 161
b) Population movement in the treated plots V_1, W_1 and F_2 162
7. Occurrence and propagation of yellows symptoms 165
8. Result of the yield evaluation 165
II. Control 1953 167
1. Formulation of the problem 167
2. Preliminary work 170
a) Application of the chemical preparation 170
b) Area of application 171
c) Aphid observation service 173
3. Organisation and implementation of spraying 173
a) Employment of technicians from the Division of Entomology and Plant Quarantine 173
b) Duties of the Orchard and Plant Protection Wardens 175
c) Equipment 175
d) Financing 176
e) Poisoning 177
4. Biological effect of "Systox" sprays 179
a) Weather 1953 179
b) Aphid development on primary and secondary winter hosts 182
c) Aphid gradation on sugar beets 182
d) Effect of the "Systox" spray on the progress of the aphid gradation 185
e) Appraisement of symptoms 188
5. Evaluation 196
Summary 197
References 198

Introduction

There is no doubt whatsoever that yellows of beets, particulary in those years when it occurs on a large scale, greatly influences the economy of sugar beet cultivation. In view of the fundamental significance of beet growing as part of the large scale arable farming carried out in Rhineland, this problem is a matter of uppermost importance.

The discovery of methods to prevent yield losses is a vital necessity for the existence of both agriculture and the sugar industry. The results available from countries abroad concerning the character and nature of yellows rendered it necessary to carry out a careful research of this disease under the conditions specific to the Rhineland in order to obtain information which could be used as a basis for the systematic development of control measures.

In 1946 the Federal Biological Institute entrusted the Institute for Fallow Crop Cultivation in Münster — or rather its branch office at Elsdorf under the supervision of Dr. W. S t e u d e l — with the clarification of these questions.

Since the significance of aphids for transmitting yellows was already an established fact, and the only way of successfully guaranteeing the beet yields was to attack them direct — in addition to such preventative measures as early sowing, tillage and fertilisation etc. — the next task was to find an aphicide which acts speedily and has a long-lasting effect. The systemically acting pesticide developed in 1949 by Messrs. Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, appeared to be particularly suited to the control of aphids transmitting yellows. By means of comprehensive preliminary tests the Branch Office at Elsdorf dealt with questions of concentrations, rates of application per hectare, spraying dates and numerous other details, with the result that in 1952, the possibility could be entertained of applying past experience to a large-scale test to be carried out under practical conditions. This large-scale test confirmed the results obtained in the preliminary tests and consequently in 1953 the knowledge gained could be applied to practical farming.

The establishment of an aphid warning service, issuing of precautionary measures linked with the toxicity of "Systox", the purchase and distribution of spraying equipment, training of spraying teams, and numerous other questions essential to large-scale application, could only be dealt with from a central office, namely the Department for Entomology and Plant Quarantine.

The purpose of this report is to describe the organisation, implementation and results of measures taken during both years.

I take pleasure in expressing my gratitude to Dr. S t e u d e l for his advice based on many years of experience. In particular he undertook the task — in co-operation with the "P f e i f e r & L a n g e n - Fabriken" — of dealing with the calculations to evaluate the 1953 campaign within the framework of a statistical mass evaluation. I would also express my thanks to the "P f e i f e r & L a n g e n - Fabriken" for their invaluable assistance. My former co-workers Dr. L i n k e (1952) and Dr. T h i e l e m a n n (1953) were entrusted with matters of a biological nature and the evaluation of the control measures, and I would also tender my thanks to them for their work.

I. Large-scale test 1952

1. Problems

The large-scale test described in this report served the purpose of narrowing down the question as to what extent it is possible to reduce the degree of yellows — and naturally also to reduce the yield losses caused by this disease — by controlling virus transmitting aphids, once it has been adequately

established experimentally that aphids can be controlled successfully by means of the systemic insecticide "Systox". Concerning the problems involved, the following may be said:

1. Yellows represents an acute danger to the profitableness of growing beets in Rhineland, and when propagated over large areas it can affect the entire structure of the agricultural industry. The results of studies on the æthiology and epidemiology of the disease, in connection with the question under discussion, can be outlined as follows: The yellow disease is transmitted by aphids. The virus itself overwinters in plants, chiefly in spinach, cabbage varieties, seed bearing plants, in beet heaps and on bushes *(Evonymus europaeus* and *Viburnum opulus).* It must also be expected that the virus overwinters in weeds and other plants. The aphids overwinter at the same sites as the virus, are infected in spring or early summer and transmit the disease to the beet fields. In addition there are also aphids which fly at a later date onto the plants etc. where the virus overwinters, and they also become infected. It is obvious that the infection potential increases progressively from spring onwards, and that the virus transmitting aphids are capable of causing infection for a relatively long period. But it also requires a short period of sucking for the disease to be transferred to the plant host.

2. "Systox" is a systemic aphicide with which plants can be protected for a long period against colonization by aphids. The preparation is capable of reducing to a minimum the mass reproduction of aphids, although it is not able to prevent the aphids flying from one plant to another, piercing the leaves etc., and passing on the disease, since like all poisons it requires a certain period before it becomes active. The prospects of finding substances which prevent aphids from flying onto and piercing plants, in other words which enable the transmitting of virus to be completely eliminated by treating the fields to be protected, in all probability amount to naught considering the information available concerning the sensual-physiological properties of the aphids.

The following principles should be observed for the control of yellows by exterminating the vectors:

The probability of beet fields becoming infected increases with the number of winged and virus-infected aphids. Consequently, as long as there are no control preparations and possibilities available, it is essential to reduce

1. the total number of aphids and the masses of the winged species and
2. the number of sites where the virus is transferred to the aphids.

In tests carried out on small plots — irrespective of the fact that a secondary effect exists due to the flying power of the aphids, which cannot be eliminated technically in the tests — no allowance is made for these two basic epidemiological factors. Admittedly it is possible, as shown by the results available, to considerably reduce the infestation density on these plots treated with "Systox", and to eliminate the propagation by wingless aphids originating from winged aphids, although it is not possible to exert any influence upon the numbers of virus transmitting mites flying onto the cultivated areas. It is, however, possible to influence the mass reproduction of these mites once they are in the stock. For these reasons tests carried out on small plots can only

furnish information about the effect of the preparation on the infestation density in the stock, whereas very little can be deduced about the effects obtainable against the disease.

On the other hand the above factors are influenced in treatments of large areas, which naturally have the character of a large-scale control, because both the numbers of the aphids as well as the increasing possibilities for virus vectors picking up the disease are reduced — the latter being possible by including in the control the virus-overwintering sites. Therefore, the control of aphids should not be limited merely to the treatment of the beet fields but must also be extended to the sites where the aphids pick up the disease. It must at all costs reduce the probability of a transmission. From these factors it must be possible to establish — if a clarification can only be obtained in large-scale tests — whether yellows can be halted by treating the vectors.

2. Test Area

A section of the common at Kappelen/Erft, north of the railway line from Grevenbroich-Neuß, was selected as the test area.

Information about the position of the test plots and the check plots (latter marked k) is given in Fig. 1.

The following farms were included in the test area:

Gilveratherhof with plots V_1—V_3,

Rittergut Veckrath with plots W_1—W_3,

Gut Hombroich with plots F_1 and F_2.

Table 1

	Areas in hectare	Sowing dates	Previous crop	Variety	Stock density hectare
V_1	10·75	April 11, 12, 15	Vegetables, potatoes	Kl.W. E. Polybeta	61880
V_2	3·25	April 9, 10	Barley	Kl.W. E.	57400
V_3	3·50	April 8	Alfalfa	Kl.W. E.	61150
Vk	2·75	April 16	Potatoes	Kl.W. E.	61560
W_1	8·00	April 8	Rye and White Clover, Alfalfa	Kl.W. E. Polybeta	58500
W_2	5·00	April 15	Potatoes	Kl.W. E.	61120
W_3	5·75	April 2, 3	Winter Barley	Kl.W. E.	60100
Wk	4·50	April 15	Vegetables	Kl.W. E.	62160
F_1	17·5	April 9,12,16	Vegetables,Wheat,Alfalfa	Kl.W. E./Kl.W. N.	71000
F_2	4·5	April 10	Vegetables	Kl.W. E.	71850
Fk	5·0	April 17	Wheat, Vegetables	Kl.W. E. Polybeta	72560

Type of soil: Diluvial deposit of fine loam with a soil rating averaging 79—80 with respect to climatic conditions.

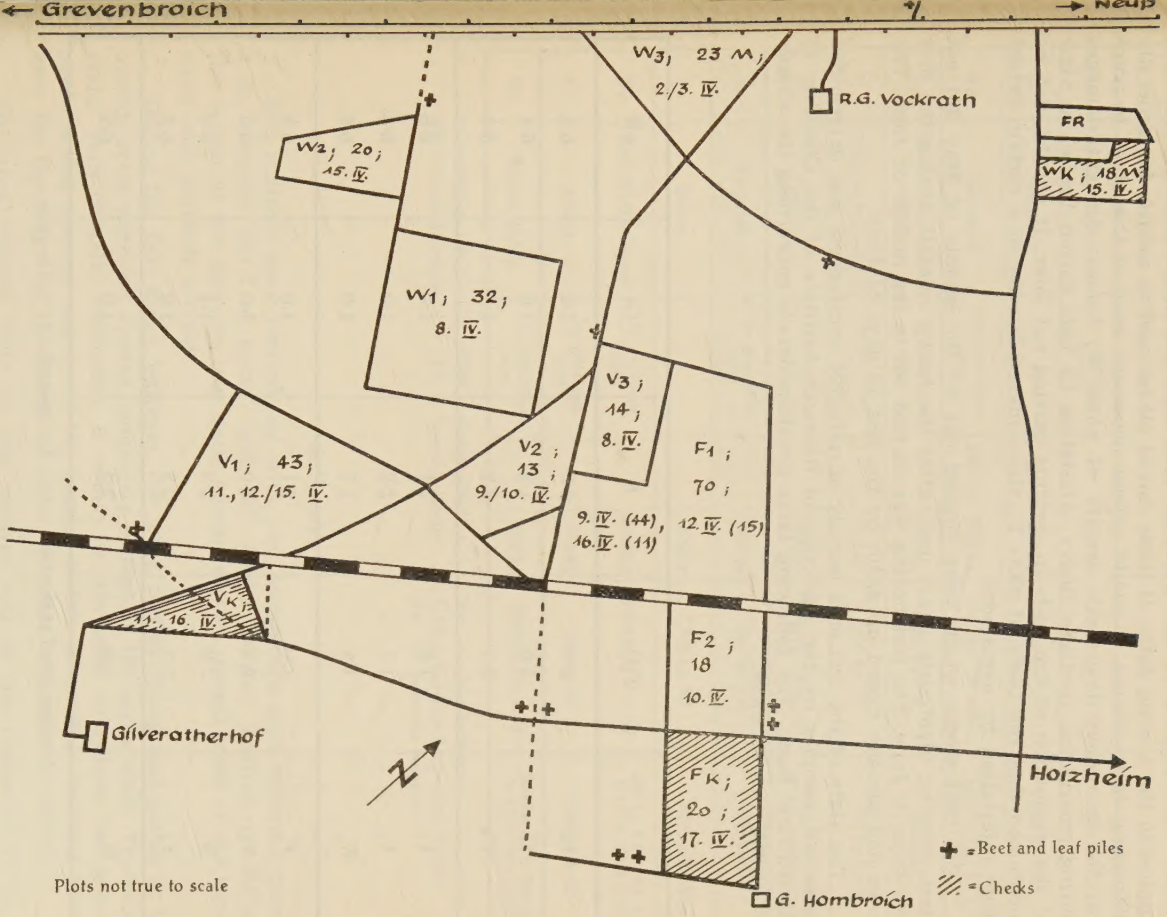

← Grevenbroich
→ Neuß
W3; 23 M;
2./3. IV.
R.G. Vockrath
FR
WK; 18 M;
15. IV.
W2; 20;
15. IV.
W1; 32;
8. IV.
V3;
14;
8. IV.
V2;
13;
9./10. IV.
V1; 43;
11., 12./15. IV.
F1;
70;
9. IV. (44), 12. IV. (15)
16. IV. (11)
VK;
11., 16. IV.
F2;
18
10. IV.
Gilverathерhof
Holzheim
FK;
20;
17. IV.
G. Hombroich
N
Plots not true to scale
= Beet and leaf piles
= Checks

Figure 1

The table shows that within the test area there are considerable differences with respect to the previous crop and the stock density. This also applies to the sowing dates, if these can at all be used as a basis for generally discussing early sowing. It would appear necessary even at this stage to point out the extremely low stock density of plots W_1 (cause: drought damage during emergence, partially heavy infestation by beet carion beetle) in view of the evaluation of the tests in weights carried out later. It should also be mentioned that the beets of plots F_2 also suffered heavily to a certain extent from infestation by nematodes.

The beet stocks which were singled out by the middle of May did not start growing vigorously again until after the heavy rainfall during the first few days in June. The last hoeing was carried out in the middle of June. The rows had already closed up again by the last 10 days of June.

The state of the test area (supply of nutritive substances) was determined from soil samples by the Agricultural Research Institute of the Chamber of Agriculture, Bonn. The following table provides details concerning the supply of nutritive substances.

Table 2

	P_2O_5	K	Ca	pH
Fk	1·0	2·0	1·0	6·4
Vk	1·0	1·8	1·0	6·4
Wk	2·1	2·2	1·0	6·3
F_1	1·8	2·1	1·5	6·0
V_1	1·7	2·8	1·0	6·4
W_2	1·9	1·7	1·0	6·5
F_2	1·0	2·1	1·0	6·3
V_2	2·1	3·0	1·0	6·3
W_1	2·8	2·9	1·4	5·9
V_3	1·5	2·7	1·0	6·3
W_3	1·8	2·2	1·0	6·2

1 = very good at the time 2 = average 3 = poor

3. Fertilization

The doses of fertilizer applied to the plots are given in the following table. Details concerning the amounts of stable manure applied to plots Vk and V_2 cannot be given with any degree of reliability.

Table 3

	Previous Crop	Stable Manure	Ca	K	P_2O_5	N
Fk	Wheat, Vegetables	to previous crop		500 kg	900 kg TM	100 kg LS
Vk	Potatoes	?		600 kg	600 kg SP	600 kg KAS
Wk	Vegetables	to previous crop	1200 kg	1000 kg	1000 kg TM + SP	300 kg SA + 300 kg KAS + 200 kg NS
F_1	Winter Vegetables, Alfalfa	to previous crop		500 kg	900 kg TM	500 kg LS
V_1	Potatoes, Vegetables	to previous crop		600 kg	600 kg SP	600 kg KAS
W_2	Potatoes	to previous crop		1000 kg	1000 kg TM + SP	300 kg SA + 300 kg KAS + 200 kg NS
F_2	Vegetables	to previous crop		500 kg	900 kg TM	500 kg LS
V_2	Barley	?		600 kg	600 kg SP	600 kg KAS
W_1	Rye, White Clover	to previous crop		1000 kg	1000 kg TM + SP	300 kg SA + 300 kg KAS + 200 kg NS
V_3	Alfalfa	to previous crop		700 kg	700 kg SP	600 kg KAS
W_3	Winter Barley	to previous crop		1000 kg	1000 kg TM + SP	300 kg SA + 300 kg KAS + 200 kg NS

K = 40% potash
SP = Superphosphate
TM = Thomas Meal
LS = Leuna Saltpetre
NS = Chile Saltpetre
KAS = Calcium Ammonium Nitrate
SA = Ammonia Sulphate

4. Sprays

The controls were carried out with two Autorecord type sprayers (swath 5 m, capacity 400 l of spray wash [2]). Under normal weather conditions, the output of the sprayers was quite adequate even though most of the leaves were only partially wetted.

During the first spray, however, the wind was so strong that plants in the outside rows were not always completely wetted by the spray wash. Therefore, under such climatic conditions, it would be advisable to reduce the driving speed of the sprayer and to set the nozzles as low as possible (making allowance for the height of the plants in order to obtain a maximum effect).

The area covered daily by one sprayer was in the region of 12 to 15 hectares. The organisation of water transport is a decisive factor in ensuring the smooth progress of spraying work. In the tests, water was supplied regularly by means of a 2500 l tank mounted on a tractor-drawn trailer, which could be filled from a hydrant by means of a standpipe.

Fig. 2 (Photo: Plant Protection Office Bonn)

Spraying Dates:

The following summary provides information concerning the spraying dates, quantities of "Systox" and spray wash applied, as well as the driving speed and the spray pressure of the apparatus:

1st Spray

V_1—V_3	May 23, 2nd gear (4—5 km/st), 10 atm./gauge	395 g/397 l/ha
W_1—W_3, F_1 & F_2	May 24, 3rd gear (7—8 km/st), 15 atm./gauge	

2nd Spray

V_1—V_3	June 6,	3rd gear, 20 atm./gauge	405 g/380 l/ha
W_1—W_3	June 10,		
F_1 & F_2	June 11,		

3rd Spray

V_1—V_3	June 26	2nd gear, 10 atm./gauge	369 g/430 l/ha
W_1—W_3	June 27		
F_1 & F_2	June 28		

The differences in the quantities applied per hectare are due to the fact that the driving speed and the spray pressure of the apparatus (see summary above) varied from spray to spray.

The emulsificability of the preparation is good.

Damages to plants were not observed.

No accidents were caused.

5. Observations on the overwintering of the vector and the yellows virus

The virus winter hosts belonging to the family of *Chenopodiaceae* play an important part in the infection chain of the yellows virus insofar as they are at present to be taken into consideration as plant hosts to *Myzodes persicae*, which overwinter outdoors under certain conditions, also anholocyclic.

For this reason it was planned to establish the location of, and to clear away all possible overwintering sites in the test area before the start of the flight period of the vectors in Spring, in order to reduce in this way the number — and in fact the possibility of occurrence — of the initial infections. Inside the test area itself, and also in the immediate vicinity, there were 13 heaps of beets and leaves — marked with crosses in test plan (1) — which were all more or less heavily colonized with virulent sprouts. One leaf heap which had almost been forgotten revealed the following when examined on May 20:

Size approx. 50 sq.m., 3—4 sprouts per sq.m.,
85 % of all sprouts infected with yellows.

With a 65 % colonisation, there were 0.8 nymphs and 1.1 larvae of *Myzodes persicae* per sprout. There were also small colonies of *Doralis fabae* on single sprouts.

Since it was not possible to clear the overwintering sites until May 21 for reasons arising out of organisation difficulties, it is very probable that winged aphids occurring in spring had already picked up the disease by this date and carried it to the beets which had already emerged. By the beginning of May, the first migrants had already left the peach trees which were growing in practically every garden in the test area. They remained on the wing until the first few days of June. No information is available about the flight of *Doralis fabae* in spring. No winged *Doralis fabae* were found in the young peach stocks. When the test was started on the 20th it was probable that the spring flight of this species, which normally begins earlier than that of *Myzodes persicae*, had already ended.

Beet seeds are not cultivated in the test area.

6. Population movement of *Myzodes persicae* and *Doralis fabae*

Since it is only possible to draw conclusions on the success of the control by comparing the population movement in the treated and untreated plots, recordings were made from the outset of the tests, at invervals of 2—5 days, of the average aphid infestation of the single beets in the plots V_1, W_1, F_2, V_1 and Fk, these recordings being made separately according to the species and their stadium. Whereas it was necessary at the beginning to make counts on 30 to 40 separate beets because of the slight aphid infestation, once the mass reproduction had started it was quite sufficient to count only 10 or 5 single beets per plot in the check plots in order to obtain average values.

a) Population movement in the check plots

The following table is based on the total numbers of aphids counted, it having been decided not to give the individual stages separately because this would make it too complicated.

The table shows the rapid increase in infestation during the month of June, leading to extremely high maxima on June 20 with respect to both species. The subsequent decline of the population density resulted all the more

Table 4

Date	Vk		Wk		Fk	
	Myzodes persicae	*Doralis fabae*	*Myzodes persicae*	*Doralis fabae*	*Myzodes persicae*	*Doralis fabae*
May 22	0·8	1·9	0·5	1·6	0·6	2·0
May 22	1·9	2·0	2·0	2·4	1·5	2·5
May 30	2·4	2·8	3·0	3·2	2·5	3·0
June 3	8·3	5·6	10·5	4·8	8·8	4·5
June 7	13·2	12·6	15·5	15·4	14·8	14·1
June 11	19·5	23·0	19·2	25·0	22·5	25·0
June 14	93·0	120·6	58·5	96·3	86·7	100·8
June 20	576·0	771·8	422·1	614·2	524·8	604·5
June 27	170·1	88·5	290·5	191·3	142·6	138·0
July 2	91·2	10·5	263·6	109·0	117·1	41·5
July 7	6·6	0·9	50·0	22·2	5·0	0·9
July 10	1·5	0·0	4·3	0·6	2·1	0·0
July 15	0·0	0·0	0·0	0·0	0·0	0·0

quickly, or suddenly, the higher the preceding maxima had been, and consequently the zero value was obtained earlier for *Doralis fabae* than for *Myzodes persicae.*

No aphids of either species were to be found on the beets on July 15.

The first signs of the collapse of the populations of both species were already perceptible on June 20. At this time there was already a varying number of fungus-covered aphids on the beets heavily colonized with *Doralis fabae.* The cause of the sudden drop in infestation during the last 10 days of June, which was earlier than usual although enforced, is attributed to the combined effects of parasitism, episitism (first and foremost *Coccinellidae)* and high temperatures during this period.

In view of the very high number of aphids counted, the infestation in the test area can be referred to as "extremely serious".

b) Population movement in the treated plots V_1, W_1 and F_2

In the treated plots, the aphid counts served both for checking the success of the control as well as for fixing the dates for spraying. Due to temporal differences with respect to the latter, it appears important to give the values separately for plots V_1, W_1 and F_2 which were kept under observation.

From the comparison drawn with respect to the population movement in the treated plots it is seen that by the beginning of the summer flight the infestation density of both vector species was reduced to a minimum by the "Systox" treatments, and the formation of colonies was completely arrested. The increase in infestation between June 13 and 25 is to be attributed to the large-scale flying activities of both species and the numbers of larvae hatched. This is shown by the following comparison of the numbers of winged aphids of both species in plots W_1 and F_2. The table also demonstrates the influence of varying stock densities on the numbers of aphids infesting them, and also the rate of increase in infestation.

Table 5

Date	V_1 *Myzodes persicae* (Aphids, total per beet)	*Doralis fabae* (Aphids, total per beet)
May 22	0·7	2·2
1st spray (May 23)		
May 26	0·45	0·6
May 30	0·3	0·2
June 3	0·6	0·6
June 5	1·1	0·9
2nd spray (June 6)		
June 9	0·2	0·18
June 11	0·05	0·10
June 13	0·10	0·8
June 16	0·5	0·2
June 18	0·7	18·2
June 21	1·6	36·6
June 25	9·6	144·3
3rd spray (June 26)		
June 30	0·3	0·7
July 2	0·5	1·1
July 4	0·1	0·4
July 7	0·0	0·15
July 10	0·0	0·0

Date	W_1 *Myzodes persicae* (Aphids, total per beet)	*Doralis fabae* (Aphids, total per beet)
May 22	0·35	1·4
1st spray (May 24)		
May 26	0·2	0·1
May 30	0·1	0·1
June 3	0·2	0·6
June 5	0·4	0·8
June 9	1·2	1·5
2nd spray (June 10)		
June 13	0·1	0·3
June 16	0·1	3·6
June 19	1·8	22·2
June 21	2·3	60·0
June 26	14·1	241·9
3rd spray (June 27)		
June 30	0·3	0·9
July 2	0·9	2·0
July 4	0·2	1·5
July 7	0·0	0·2
July 10	0·0	0·0

Date	F_2 *Myzodes persicae* (Aphids, total per beet)	*Doralis fabae* (Aphids, total per beet)
May 22	0·4	1·3
1st spray (May 24)		
May 26	0·15	0·4
May 30	0·1	0·1
June 3	0·1	0·5
June 5	0·5	1·0
June 9	1·1	1·4

Date	F_2 *Myzodes persicae* (Aphids, total per beet)	*Doralis fabae* (Aphids, total per beet)
2nd spray (June 11)		
June 13	0·05	0·2
June 19	0·4	7·7
June 21	1·0	25·0
June 26	6·0	49·6
3rd spray (June 28)		
June 30	0·1	0·6
July 4	0·08	0·4
July 10	0·0	0·0

Table 6: Winged aphids per plant

Date	V_1		Vk	
	Myzodes persicae	*Doralis fabae*	*Myzodes persicae*	*Doralis fabae*
June 16	0·0	2·0	0·0	1·2
June 18	0·6	9·2	0·0	1·0
June 21	1·0	11·0	0·6	4·0
June 26	2·5	16·2	1·1	6·2
June 30	0·3	0·9	0·1	0·4
July 2	0·9	2·0	0·2	0·7
July 4	0·2	0·6	0·08	0·4

The table shows that plot F_2 (stock density 69 000/hectares) was not so densely colonized as plot W_1 which had a stock density of only 45 000/hectares.

The third spray carried out on June 26, 27 and 28 again had the effect of considerably reducing the infestation, although it ought to have been started several days earlier in order to prevent the preceding increase in infestation. This, however, was not possible due to the weather.

The heavy colonization proves that the secondary effect which is found to be disturbing in small plot tests cannot be eliminated even in a large scale test if fields are left untreated in and around the test area. This aim could probably have been achieved by carrying out more extensive treatments of all beet areas. The practical efficacy of this measure is made evident by the observation that the development of nymphs in the treated plots was more or less arrested. Evidence of this is given in the following comparison of the numbers of nymphs of both species counted in a treated (V_1) and in an untreated (Vk) plot.

Table 7: Nymphs per plant

Date	W_1		Vk	
	Myzodes persicae	*Doralis fabae*	*Myzodes persicae*	*Doralis fabae*
May 26	0·0	0·0	0·0	0·25
May 30	0·0	0·0	0·0	0·6
June 3	0·0	0·0	1·0	0·8
June 7	0·0	0·0	1·9	3·6
June 11	0·0	0·0	6·4	6·6
June 14	0·0	0·0	20·3	46·2
June 16	0·1	0·1		
June 18	0·1	0·1		
June 20	0·1	0·2	145·5	316·4
June 25	0·5	0·3		
June 27	0·0	0·0	45·6	23·1
July 2	0·0	0·0	31·4	2·5
July 7	0·0	0·0	1·3	0·0
July 10	0·0	0·0	0·0	0·1

Whereas the numbers of nymphs in the check plots reached a maximum of 145·5 for *Myzodes persicae* and 316·4 for *Doralis fabae*, they occurred on such a large-scale in the treated plot taken as an example that it was hardly possible to count them, added to which they occurred only between June 16 and June 25.

By almost completely eliminating the development of nymphs and — as a result — winged aphids, the propagation of the infection in the stock is reduced.

The indirect success gained with respect to extermination was satisfactory for all sprays.

The slow effect following the first spray (see population movement in V_1), which did not reach an optimum until after seven days, can be attributed to the abnormal weather conditions prevailing during this period (strong wind, temperatures not rising above 13° C), while on the other hand the rapid effect following the third spray was due to the high temperatures (up to 29° C) at the time of application.

Evidence of the systemic efficacy of the preparation was furnished by the success of the second spray, which was surprising considering that a heavy downpower of rain lasting 45 minutes began 30 minutes following the treatment of plot V_1.

7. Occurrence and propagation of yellow symptoms

The first symptoms occurred on June 20, both in the check and the treated plots, although up to the middle of August propagation was more rapid in the untreated plots — with a greater degree of infestation — as shown in the following table:

Table 8: Virus infestation in % (average taken from the evaluation of each 150—200 beets)

	Vk Degree of Symptoms						V_1 Degree of Symptoms					
Date	1	2	3	4	5	Total	1	2	3	4	5	Total
July 7	7·8	1·5	0·2	0·0	0·0	9·5	3·0	0·5	0·0	0·0	0·0	3·5
July 15	1·0	31·0	33·0	19·0	0·0	84·0	19·0	10·0	4·0	0·0	0·0	33·0
July 23	5·6	22·1	37·0	29·8	0·0	94·5	33·4	25·9	3·7	0·0	0·0	63·0
August 22	4·6	34·2	33·2	23·4	4·6	100·0	25·6	35·2	15·8	13·8	0·0	90·4

From the middle of August onwards, the check and the treated plots revealed 100 % virus infestation. No further evaluations were carried out after this date.

8. Result of the yield evaluation

Since the evaluations of the beet stocks carried out during the vegetation period to determine the degree of virus infestation do not represent a reliable criterion by which the success of the control measures can be judged, uprooting in the test and check plots was carried out on October 9 and 10, 1952 to determine the yield of beets and leaves, and to make an estimate of the quality of the harvest. 10 plots, each 25 sq.m. in size, were uprooted in each of the check

areas Vk, Wk and Fk, and also in the treated areas V_1, W_2 and F_1, lying next with respect to the sowing date of the check areas; from the remaining treated areas V_2, V_3, W_1, W_3 and F_2, eight 25 sq.m. plots were uprooted in each. This gave a total of 30 check plots and 70 treated plots for the purpose of drawing comparisons. Before the beets were lifted, the failures in each plot were counted. The determination of the weight of hand-topped beets and of the leaves was carried out on the spot by means of field scales (Fig. 3); 100 beets from each plot and one leaf sample were sent by truck immediately after lifting to the Agricultural Research Institute at Bonn to be examined for their degree of polarisation, harmful nitrogen and ash content. The result of the findings is given in Table 9.

Fig. 3 (Photo: Plant Protection Office, Bonn)

Before tabulating and discussing the results, it appears necessary to make a closer study of the field and test conditions. From the very outset, it was perfectly clear that a large scale test would be influenced by the lack of non-uniformity among the individual plots, and there is no doubt whatsoever that this fact greatly limited the possibilities of evaluation. On comparing the results of the evaluation given in Table 9, we arrive at the following:

1. Consistency with respect to sowing dates only exists between the plots of group k (Fk, Vk, Wk) and group I (F_1, V_1, W_2). The beets of the other test areas were sown 5 to 10 days earlier than those of groups k and I.

2. The previous crops of the single test and check plots differ.

3. The amounts of fertilizer applied in the fields belonging to one particular farm are always the same. The stock densities are also practically equal. The applications of stable manure vary.

4. The results of the studies carried out to determine the P_2O_5, K and Ca content of the soil and also to establish the soil reaction reveal considerable fluctuations. There are only slight deviations among the pH values which characterize the examined soils as being neutral to weakly acid. Plot W_1 has a tendency towards the negative side with a pH value of 5·9. No definite relations can be established between the doses of fertilizer and the yields on the one hand, and the fertilizer doses and the results of the soil studies on the other.

The results of the yield determinations and the chemical analyses of the sugar beets are given in column 3, in which the single plots are listed in three groups according to the dates on which they were sown. The result of comparing the average values of the single groups is as follows:

The beet yield in the test plots of group 1 is 58·2 %, polarisation 9 %, sugar yield 73·4 % and the leaf yield 31·9 % higher than in the check plots (group k). The corresponding values for a comparison of the checks and group II (earlier sowing date) are 37·5 %, 10·4 %, 51·5 % and 23·1 % respectively. On comparing the average values of the checks (30 liftings) with the average values of all treated plots (70 liftings), it is found that the beet yield, polarisation, sugar yield and leaf yield of the latter are 45·8 %, 10·8 %, 61·4 % and 24·4 % higher respectively.

The original findings of the investigations are filed at the Plant Protection Office.

Consequently the large-scale test proved that even under practical conditions, chemical controls can be carried out successfully. However, it appears necessary to point out that as a result of the inconsistency of the test conditions mentioned above, and moreover due to the fact that, contrary to long years of experience, the early sown plots had lower yields than those sown later — added to which there were no untreated check plots for the former — the test under discussion cannot be rated as an exact test in the actual sense of the term.

II. Control 1953

1. Formulation of the problem

Sugar content of beets in %
(according to data of the Sugar Trade Association)

Campaign	50/51	51/52	52/53
North Rhine	15·54	14·81	13·71
Federal area	15·98	16·20	15·35

Faced by the consequences of the "yellow year" in 1952, all circles concerned had agreed at the end of 1952 that in view of the ever-increasing drop in the

Table 9

Designation and size of field (hectares)	Date of sowing	Previous Crop	Stock density (hectares)	Stable manure	1) Fertilization per hectare				2) Average s of the so		
					Ca	K	P_2O_5	N	P_2O_5	K	Ca
Group k											
Fk 5·00	April 17	Wheat Vegetables	72 560	to previous crop		500 kg K	900 kg TM	500 kg LS	1·0	2·0	1·0
Vk 2·75	April 16	Potatoes	61 560	?		600 kg K	600 kg SP	600 kg KAS	1·0	1·8	1·0
Wk 4·50	April 15	Vegetables	62 160	to previous crop	12000 kg lime	1000 kg K	1000 kg TM + SP	300 kg SA 300 kg KAS 200 kg NS	2·1	2·2	1·0
		Average value:	65 427								
Group I											
F_1 17·5	April 16	Winter vegetables alfalfa	71 000	to previous crop		500 kg K	900 kg K	500 kg LS	1·8	2·1	1·5
V_1 10·75	April 15	Potatoes vegetables	61 880	to main crop		as for Vk			1·7	2·8	1·0
W_2 5·00	April 15	Potatoes	61 120	to previous crop		as for Wk			1·9	1·7	1·0
		Average value:	64 667								
Group II											
F_2 4·50	April 10	Vegetables	71 850	to previous crop		as for Fk			1·0	2·1	1·0
V_2 3·25	April 9 and 10	Barley	57 400	?		as for Vk			2·1	3·0	1·0
W_1 8·00	April 8	Rye, White Clover	58 500	to previous crop		as for Wk			2·8	2·9	1·4
V_3 3·50	April 8	Alfalfa	61 150	to main crop		700 kg K	700 kg SP	600 kg KAS	1·5	2·7	1·0
		Average value:	62 225								
W_3 5·75	April 2 and 3	Winter barley	60 100	to previous crop		as for Wk			1·8	2·2	1·0
		Average value: (check)	65 427								
		Average value: (treatment)	62 875								
		Relative figures: (Check = 100)	96·1								

Explanation to table:

Group k = untreated
Group I, II and W_3 = 3 × 400 g "Systox"

Gross ield 00 kg)	Adjusted weight	m %	% Pol.	m %	100 kg/ha sugar	Nmg 1·100 g	soluble A. %	100 kg/ha leaf	R : B = 100 : x
08·7	344·6	4·273	13·16	2·652	45·2	49·2	0·46	438·5	127·17
33·6	291·3	3·659	13·44	1·843	39·3	53·9	0·41	284·8	97·69
39·2	304·4	3·731	12·70	1·639	38·8	51·5	0·59	410·0	134·48
60·5	313·4	3·888	13·10	2·045	41·1	51·5	0·49	377·8	119·78
76·2	570·7	2·225	14·95	1·230	85·2	51·0	0·35	539·8	94·57
69·0	515·5	2·283	14·70	1·307	75·8	48·3	0·40	524·3	101·86
24·9	401·4	3·718	13·18	2·231	52·9	46·6	0·53	430·0	107·07
23·4	495·9	2·742	14·28	1·589	71·3	48·6	0·43	498·4	101·17
90·7	478·6	4·621	13·85	0·983	66·2	39·3	0·36	514·9	107·56
74·3	513·4	3·550	14·75	1·284	75·7	52·0	0·37	444·9	86·70
97·1	359·4	4·081	13·84	2·694	49·7	57·0	0·53	461·5	128·38
16·1	373·2	2·750	15·40	1·384	57·5	54·0	0·27	439·3	117·69
94·5	431·15	3·755	14·46	1·586	62·27	50·57	0·38	465·15	110·08
93·4	442·2	2·676	15·48	2·008	68·5	57·0	0·35	413·3	93·46
50·5	313·4	3·888	13·10	2·045	41·1	51·5	0·49	377·8	119·8
05·2	456·8	3·240	14·52	1·640	66·4	50·6	0·39	471·1	104·8
40·1	145·8		110.8		161·4	98·2	79·6	124·4	87·0

) K = 40 % potash
SP = Superphosphate
TM = Thomas Meal
LS = Leuna Saltpetre
NS = Chile Saltpetre
KAS = Calcium Ammonium Nitrate
SA = Ammonia Sulphate
to 2) 1 = good at the time
2 = average
3 = poor

sugar content of beets in Rhineland, intensive measures would have to be taken to control the yellow disease.

In numerous exact tests which he carried out in 1952, together with multiple replications, Steudel obtained such good results by applying "Systox" that the effects on the gross beet yields, the leaf mass and the sugar content were exclusively positive.

Sowing season test, Birkhof near Neuss, 1952

Sowing date	Beets untreated	100 kg/ha treated	Smaller yield %	Polarisation in %		Loss
				untreated	treated	
April 15	390	457	— 14·6	13·32	13·63	— 0·31
April 28	237	320	— 25·9	12·65	13·27	— 0·62
May 13	143	159	— 11·0	11·40	12·21	— 0·81

This tendency of the yield results to be consistent with the large-scale consumption described beforehand, in relation with the organisation experience gained, provided the Plant Protection Office with the fundamentals for applying the preparation on the widest possible basis.

It was, therefore, planned to carry out a large-scale control of aphids with "Systox" in 1953 in Rhineland.

As this plan was being carried out for the first time, it could not be put into operation until all the factors serving to increase the economy had been thoroughly checked and allowed for.

2. Preliminary work

a) Application of the chemical preparation

The Minister of Labour, Social Welfare and Reconstruction for Land North-Rhine/Westphalia had issued regulations restricting the use of the chemical preparation "Systox" on the grounds of its toxicity. Consequently it was only possible to carry out a large-scale control provided all the necessary safety measures had been taken beforehand, i. e. as soon as there was absolute clarity with respect to danger to humans and animals. A meeting was called for the 20th of December, 1952 at the Robert-Koch-Institute, Berlin, for the purpose of establishing whether by taking appropriate precautionary measures the risk of inflicting health injuries could be reduced to such an extent that it would be possible to apply "Systox" in 1 to 2 sprays.

According to Prof. Dr. Borgmann of the Robert-Koch-Institute, Berlin-Dahlem, "Systox" possesses a considerably higher vapour tension than "E 605". This means that there is a danger of intoxication caused by inhaling the vapours, added to which the preparation is far more effective percutaneously (90 mg "E 605"/kg : 25 mg "Systox"/kg rabbit). From this, it is to be concluded that with the application of "Systox", inhalations and percutaneous consumption of spray washes are in the main to be expected, and consequently have to be prevented. By wearing a suitable respirator — the use of the Draeger half-face mask 70 with insert 624 A and large dust filter was prescribed — and rubber gloves, plus the application to the skin of barrier cream, it was believed

that the danger of poisoning could be reduced considerably. Furthermore it was decided not to supply the preparation "Systox" direct to the user but to make it available for use via an organisation held responsible for the control. The Association of Trained Orchard and Plant Protection Wardens was given this assignment, and its members were to be given thorough training before taking up these new duties.

The Federal Biological Institute, the Farbenfabriken Bayer Aktiengesellschaft, the public health authorities and the Department of Entomology and Plant Quarantine cooperated in preparing a leaflet giving instructions on the precautions to be taken in the application of "Systox". (See enclosure in the cover flap.)

The packing of the preparation itself was made subject to definite regulations:

Only to be filled in aluminium containers fitted with proper stoppers, and conspicuous labelling with clear reference to toxicity.

In the Agricultural Journal of North-Rhine Province, explanations were given to farmers of the bulletins issued by the Extension Service, stipulating which measures they had to observe after treating the beet fields with "Systox". With respect to the danger of animals breaking out, all cattle breeders were instructed to check the fencing around their pastures and meadows. Beekeepers were informed of the plan to carry out the control, and also of the dates when spraying would commence.

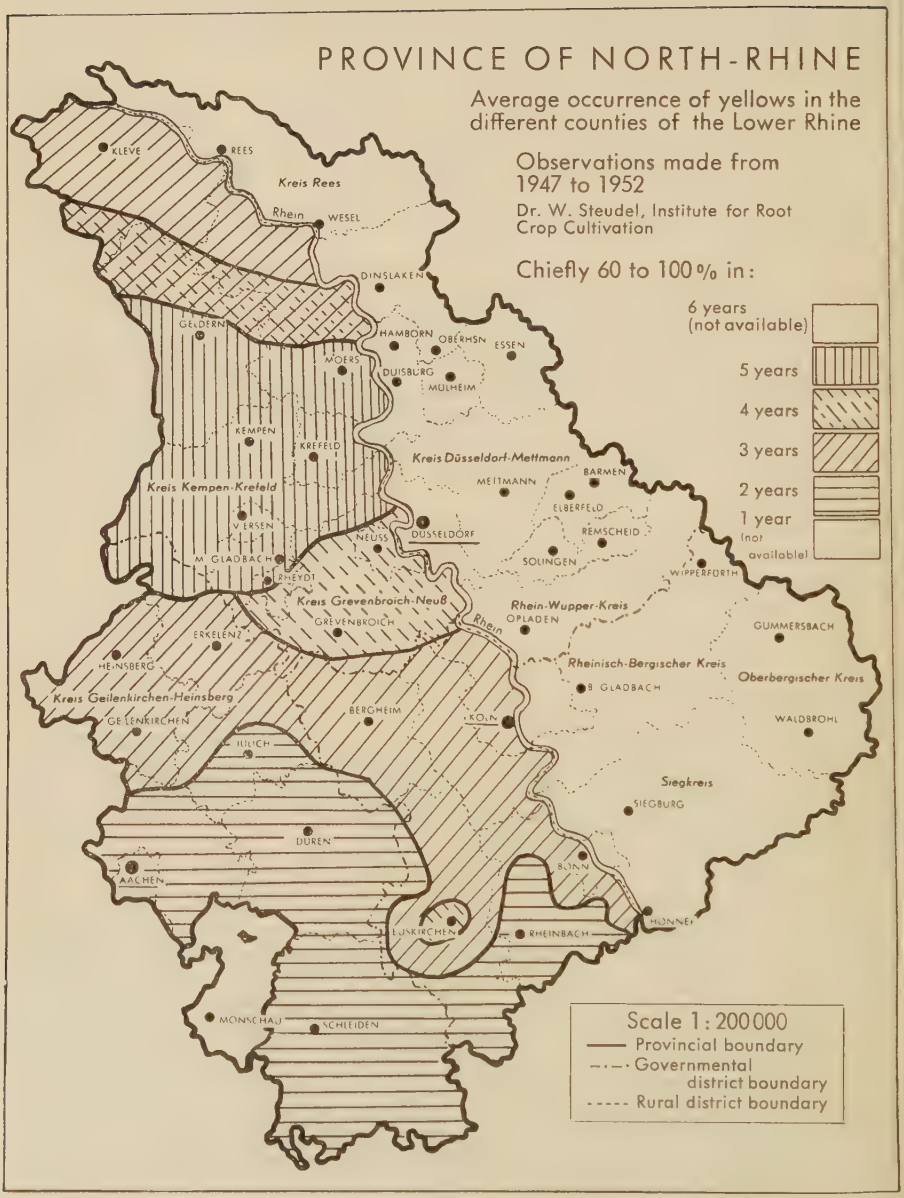
Doctors practising in the districts involved were informed of the plan by their competent Provincial Ministry, so that they would be on call to treat any cases of poisoning with appropriate antidotes.

The Minister of Labour, Social Welfare and Reconstruction for Land North-Rhine/Westphalia, after examining all the documents submitted with respect to precautionary measures, granted the application of the Division of Entomology and Plant Quarantine for the release of "Systox" to be used to control yellows of sugar beets in the rural districts of Grevenbroich, Bergheim and Cologne. The condition for this approval was the strict compliance with the organisation plan of the Division of Entomology and Plant Quarantine whereby the latter was held responsible for management and supervision, moreover to employ trained plant protection and orchard wardens for carrying out the sprays, and only to engage suitable persons as extra help.

b) Area of application

Sugar beet growing in Rhineland is concentrated chiefly in the districts of Grevenbroich, Bergheim, Cologne, Jülich, Aachen and Euskirchen. Since many years of experience have shown that the yellow disease occurs on a particularly large scale in the first three of the above-mentioned districts — also perceptible from Steudel's map (Fig. 4) — added to which the cultivation of beets is more extensive here, they were unanimously selected for the application of "Systox" by all parties participating in the organisation (Federal Biological Institute, Branch Office for Fallow Crop Cultivation, Elsdorf/Rhineland, Division of Entomology and Plant Quarantine, Rhenish Beet Growers' Association e. V., Sugar Industry). It was not possible to extend the control area to other districts for reasons of organisation, since the Minister of Labour, Social Welfare and Reconstruction had given his approval for the use of "Systox" only on condition that the Provincial Association of Trained Orchard and Plant

Fig. 4


PROVINCE OF NORTH-RHINE
Average occurrence of yellows in the different counties of the Lower Rhine
Observations made from 1947 to 1952
Dr. W. Steudel, Institute for Root Crop Cultivation
Chiefly 60 to 100% in:
6 years (not available)
5 years
4 years
3 years
2 years
1 year (not available)
KLEVE
REES
Kreis Rees
Rhein
WESEL
DINSLAKEN
GELDERN
HAMBORN
OBERHSN
ESSEN
MOERS
DUISBURG
MÜLHEIM
KEMPEN
KREFELD
Kreis Düsseldorf-Mettmann
Kreis Kempen-Krefeld
MEITMANN
BARMEN
ELBERFELD
VERSEN
NEUSS
DÜSSELDORF
REMSCHEID
M. GLADBACH
RHEYDT
SOLINGEN
WIPPERFÜRTH
Kreis Grevenbroich-Neuß
Rhein-Wupper-Kreis
OPLADEN
GREVENBROICH
Rhein
GUMMERSBACH
ERKELENZ
HEINSBERG
Rheinisch-Bergischer Kreis
Oberbergischer Kreis
Kreis Geilenkirchen-Heinsberg
B. GLADBACH
GEILENKIRCHEN
BERGHEIM
KÖLN
WALDBRÖHL
JÜLICH
Siegkreis
SIEGBURG
DÜREN
BONN
AACHEN
EUSKIRCHEN
RHEINBACH
MONSCHAU
SCHLEIDEN
Scale 1 : 200000
Provincial boundary
Governmental district boundary
Rural district boundary

Protection Wardens participated, and this association had not enough members to deal with a control extending beyond these three districts.

During the lectures held in winter, particular importance was attached to acquainting beet growers with the possibilities for preventing and controlling yellows. Each grower was supplied from the Sugar Industry with Leaflet No. 9 published by the Federal Biological Institute. (See enclosure in the cover flap.)

As the result of these meetings which served the purpose of informing growers of the plant control action, and also following the distribution of a leaflet signed by the sugar industry, the Association of Beet Growers and the Plant Protection Office asking farmers to participate voluntarily and to report the area of their beet fields to be sprayed to the sugar factories, the majority of the growers undertook to spray a total area of 42 129·38 morgen. (See enclosure in the cover flap.)

The area to be sprayed was made up as follows:

Cologne — town and country	11 103·25 morgen
Bergheim	15 306·00 „
Grevenbroich	15 720·58 „
	42 129·38 morgen

In order to supervise the areas better, they were subdivided into spraying districts, each under one plant protection technician and 5 to 8 orchard wardens.

c) Aphid observation service

The success of a "Systox" treatment depends first and foremost upon the spray being carried out at the right time. In order to fix the spraying dates, an aphid observation service was organised spread out over the whole of Rhineland. At 10 stations, the development of the aphids on winter hosts (peach, *Evonymus europaeus, Viburnum opulus)* and on field stocks (beets, potatoes, cabbage) was checked at intervals of 3 days by 10 students during the period from May 5 to June 30. 100 beet plants were examined in at least 12 fields distributed over the district where the counts were made. Special attention was to be given to half of the fields which were sown early and to the remainder at a later date. The actual control district was also subdivided into fields which were to be sprayed and those to be left untreated in order lo keep a check on the effect of "Systox" by making separate counts. These observations were kept up until the end of July in the spraying area. The stations immediately passed on the results of the counts to the Division of Entomology and Plant Quarantine so that the latter could follow the development of the virus vectors from the figures submitted.

3. Organisation and implementation of spraying

a) Employment of technicians from the Division of Entomology and Plant Quarantine

The technicians of the Division of Entomology and Plant Quarantine were entrusted with the task of starting preparations to carry out the sprays in the various districts, working according to an exact plan.

The following points had to be dealt with:

1. To determine what types of sprayers were to be used making allowance for cultivation conditions.
2. To decide what tractors were to be used.
3. Provision of water.

The tasks during the control action included:

1. To see that the instructions of the Minister of Labour, Social Welfare and Reconstruction with respect to hygiene were complied with during the application of "Systox".
2. Supervision of the actual spraying work, and to deal with technical or organisation difficulties.

In each district enough tractors had to be made available for transporting water and drawing spray equipment in order to carry out the control. The tractors were switched from one job to another every half day. While driving tractors drawing sprayers, the drivers had to wear respirators. The application of the spray wash took approximately 10 minutes dependent upon the size of the container. Afterwards there was an interval of 5—10 minutes due to the fact that the sprayers hat to be driven back and to in order to be filled up with new supplies of spray wash. This gave the tractor drivers enough time to have a rest.

The local authorities were requested to make a required number of water hydrants available for the control action. Approximately 800 l of water were required per hour and per sprayer.

The technicians also had to arrange for the accomodation of the orchard wardens, to take them to their districts and to provide them with the necessary protective and working equipment. One difficulty arose in that most of the orchard wardens lived in the districts where fruit growing is chiefly carried out and not in the sugar beet growing district.

The following protective and working equipment was issued:

1 Draeger half-face mask type 70 with filter 624a
1 pair of rubber gloves
2 measures
1 block of time sheets and
list of growers with working areas in hectares.

The technicians also had to arrange for the required quantities of "Systox" to be supplied to the orchard wardens every day. The Association of Trained Orchard and Plant Protection Wardens sent 106 members to take part in the control.

From the figures sent in by the Aphid Observation Service up to May 25, 1953, the Division of Entomology and Plant Quarantine was able to send out a preliminary warning on May 28 to the wardens taking part in the control to hold themselves ready to start spraying. Although June 5 was fixed as the date to start spraying, the control had to be postponed until June 13 because of unfavourable weather conditions. A further postponement until June 15 was made necessary because of long periods of rainfall. It was originally planned for the treatment to last 5 days, but this period had to be doubled because of bad weather and other unforeseen difficulties, so that the action did not come to an end until June 25.

b) Duties of the Orchard and Plant Protection Wardens

The duty of the spray wardens was to maintain and operate 1 to 2 sprayers in one of the districts. They were also responsible for seeing that the sprays were started on the right date — basing this on the warning given — that a spray concentration of 400 c. c. of "Systox" in 400 l of water per hectare was applied, and that the entire area of the fields registered was treated, and that no gaps were left. Spraying was not to be interrupted on Sundays and holidays.

The preparation of the spray wash had to be carried out solely by the orchard warden, paying particular attention to all the safety regulations issued. This meant that untrained farm hands did not need to come into contact with the spray wash. The wardens were also given an opportunity of having a rest and were also able to remove their respirators after the sprayers had been refilled each time.

From the reports sent in by the wardens giving details of the work carried out, it was calculated that by the end of the control an area of 41 869·65 Morgen had been treated. The fact that this figure differed somewhat from the total area originally registered for treatment was due to the fact that several farmers decided at the last minute that the ground was too wet for tractors and sprayers to be driven over the fields, while in other cases the stocks were too high.

During the control action, plant protection officials, orchard wardens and representatives from the sugar industry met every evening in order to discuss the progress of the control measures and to smooth out any difficulties which had ben encountered.

Following a discussion between Steudel and Schumacher on July 1, 1953, it was decided not to carry out a second treatment of the beet fields because this would have involved difficulties of an economical nature, added to which it would have been too late to start spraying due to the postponement of the first control.

c) Equipment

After drawing up an estimate making allowance for five days of usage at 10 hours each day, swath, container capacity and driving speed, it was decided to employ the following sprayers:

27	Fricke High pressure sprayers	("High pressure trailer type sprayer Fribel II")
25	Holder „ „ „	("Universal field sprayer")
19	Platz „ „ „	("Patria I")
6	Blasator „ „ „	("High pressure trailer type sprayer")
44	Mauser Horse-drawn sprayers (fitted to be drawn by tractor)	("Horse-drawn field sprayer VII/51")
8	Auto-Rekord sprayers (Holder)	

Swath and capacity:

25	High pressure sprayers	with a swath of	and container 10 m capacity of	600 l.
52	„ „ „	„	9 m „	300 l.
8	Auto-Rekord sprayers	„	5 m „	400 l.
44	Horse-drawn sprayers	„	5·5 m „	250 l.

The sprayers were allocated according to the cultivation conditions in the various districts (distance between rows of beets), the area to be treated and their daily output which was estimated at 100 Morgen for high pressure sprayers and 60 Morgen for horse-drawn sprayers.

Grevenbroich	Bergheim	Cologne
4 Blasator type	15 Fricke type	2 Blasator type
12 Fricke type	10 Holder type	3 Auto-Rekord type
19 Platz type	5 Auto-Rekord type	15 Holder type
15 Mauser type	18 Mauser type	11 Mauser type

The sprayers were equipped by the manufacturers as follows:

Bevel blast nozzles producing droplet sizes of 100—200 μ, adjustable type distribution pipes with nozzles fitted in series, discharge of spray wash = 400 l/hectare, metal container.

After the sprayers had been on heavy duty for a period of 10 days during the large-scale control, it was possible to arrive at the following conclusions with respect to their performance:

1. Blasator: No faults found.
2. Fricke: Sturdy apparatus; a spray wash container with a capacity of 600 l is required for a working width of 10 m.
3. Platz: Distributor tube too weak, not up to the bumps and strain, and should be reinforced.
4. Holder: Distributor tube also too weak. Wheels should be fitted with ball bearings; despite good lubrication, axles jammed tight.
5. Mauser: Requires a stronger and longer trailer coupling. Moreover the very narrow lubrication channels led to faults.

At the end of the control action the sprayers were collected together and overhauled by the sugar factories, so that they would be ready for further use at any time.

d) Financing

Negotiations were held with the ministries prior to the control to clarify the question concerning the advanced payments required. The Federal Minister of Food, Agriculture and Forestry granted funds to purchase the sprayers*).

27 Fricke High spressure sprayers
25 Holder „ „ „
19 Platz „ „ „
6 Blasator „ „ „
34 Mauser Horse-drawn sprayers (fitted to be drawn by tractor)

208 594·90 DM

*) 10 Mauser horse-drawn sprayers and 8 Auto-Rekord sprayers were already available.

The Provincial Ministry of Food, Agriculture and Forestry undertook to bear the costs for the Aphid Observation Service and the purchase of respirators, including spare filters:

Reimbursement for students working in the aphid observation service, travelling expenses including vehicle maintenance	9 540·40 DM
respirators, including spare filters with accessories:	8 867·04 DM
	18 407·44 DM

The sugar industry undertook to purchase "Systox" and to make it available at their factories when required, and also to pay the orchard wardens in advance. Furthermore, this industry undertook to deduct the spraying costs per Morgen on payment of beet money to the farmers.

Settlement of accounts between the sugar industry and the Provincial Association of Trained Orchard and Plant Protection Wardens was based on DM 1·20 per Morgen, amounting to

41 869·65 Morgen à 1·20 DM	50 243·58 DM
Additional costs for journeys, partial expenses, food, accomodation	2 051·25 DM
this meant that the Provincial Association had a total sum of	52 294·83 DM

to be settled with its members.

The members of the Provincial Association were paid 3·00 DM per hour, based on a trained worker's net rate of DM 1·50 plus poison money, entrepreneurial expenses and profits, and turn-over tax. Furthermore, the Provincial Association of Trained Orchard and Plant Protection Wardens took over the purchasing costs for blocks of time sheets and delivery notes, rubber gloves, barrier cream, preparation costs, telephone and telegram fees and office material.

The treatment costs per Morgen for a "Systox" spray added to:

1. Costs for "Systox" used (4 152·63 kg à 78·69 DM)	326 770·46 DM
2. Wages of orchard and plant protection wardens plus expenses	52 294·83 DM
3. Costs of repairing and maintaining sprayers used	957·25 DM
	380 022·54 DM

380 022·54 DM : 41 869·65 Morgen = 9·08 DM/Morgen

The expenses per Morgen were calculated at 9·10 DM. The additional 0·02 DM had to be charged to cover hiring costs and insurance premiums. (Equipment and garaging.)

The "Systox" consumption was calculated as follows:
4 152·63 kg : 41 869·65 Morgen = 0·099 kg/Morgen

Water consumption, hiring charges for tractors, and petrol costs were shared by the parties concerned.

e) Poisoning

The toxic effect of "Systox" on warm-blooded animals is based chiefly on an inhibition of the cholinesterase, and the resultant excitation of the parasympathetic nerve system.

Intoxication — apart from oral consumption — may be caused by inhaling the spray mist and also as the result of percutaneous consumption.

According to the Plant Protection Department of Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, the symptoms of slight cases of poisoning are nausea and giddiness, and in serious cases vomiting, occasional disturbances of the stomach followed by diarrhœa, cold perspiration, miosis consequently disturbing vision, and in very serious cases unconsciousness and edema of the lungs. In addition fibrillary twitchings of the muscles are observed.

The safety regulations are issued to instruct users and spraying teams on the handling of "Systox", and the precautionary measures are to protect personnel engaged in spraying against intoxication resulting from oral and percutaneous consumption of the "Systox" solution and inhalation of the spray mist.

During the period of the "Systox" action, the precautionary measures and the safety regulations issued were strictly observed, with the result that there were only a few cases of poisoning.

Case 1 — June 18, 1953:

Poisoning symptoms (giddiness, headache, vomiting) on a tractor driver who had been driving a sprayer each day (as from June 14). Such precautionary measures as wearing a respirator and protective clothing are said to have been observed.

Case 2 — June 18, 1953:

Poisoning symptoms (giddiness, headache, vomiting) observed on a farmhand. He was not directly engaged in the "Systox" action, but had been working temporarily at the place where the sprays were applied. The precautionary measures had not been observed.

Case 3 — June 22, 1953:

Serious poisoning symptoms (vomiting, diarrhœa, muscle twitching) on an orchard warden taking part in the "Systox" action. The patient had to be admitted to hospital.

Case 4 — June 22, 1953: similar to Case 3

Case 5 — June 22, 1953: similar to Cases 3 and 4

Case 6 — June 22, 1953:

Slight symptoms of poisoning on an orchard warden directly engaged in the "Systox" action. Admission to hospital was not necessary.

Case 7 — June 23, 1953: similar to Case 6.

In Cases 3, 4, 5, 6, 7, the precautionary measures are said to have been observed.

Case 8 — June 23, 1953:

Slight symptoms of poisoning (headache, nausea, giddiness) on a woman who started to work in a wash-house where empty "Systox" containers had been placed.

Eight cases of intoxication were reported. The majority occurred approximately one week after the controls were started. This can be explained either by the fact that there was a slackening in the precautions taken, or that harmful effects occur following a lengthy period of control work which cannot

be eliminated by the stipulated wearing of respirators etc. Should the former be the case, then it will be necessary to carry out stricter supervision which, however, can hardly be undertaken from a central point. It was only possible to visit each of the spraying teams for a short time each day.

Should it be established, however, that the second supposition is correct, then it will be necessary for more relief personnel to be engaged so that each spray warden is only on duty for short periods, which anyway would be desirable for biological, and probably economic reasons.

The agricultural colleges were requested to pay particular attention as to whether an effect of the insecticide had been observed on small game and birds.

Cases were reported of hares and partridges being poisoned. Unfortunately it was not possible to supply the Division of Entomology and Plant Quarantine with material evidence.

In the district of Bergheim, two cases were reported of cows giving less milk. Allegedly, they had been fed on beet leaves (foddering in September, sprays carried out in June) originating from fields treated with "Systox". Unfortunately, it could not be established whether this was due to the effects of "Systox", although there was an inclination to believe that the reduction in the amount of milk given was caused by errors in the foddering methods employed.

4. Biological effect of "Systox" sprays

a) Weather 1953

A change to mild weather bringing to an end almost three months of continuous winter conditions set in from the middle of February, 1953 onwards resulting from the passage of Atlantic air currents over the mainland. A wide belt of high pressure over Central Europe brought warm and sunny Spring weather with it. The unusually long period of sunshine quickly heated the soil so that the sowing of sugar beets could be started as early as the second half of March. By the end of March, the development in nature was more than a week ahead in comparison with normal years.

During the first half of April there were frequent changes in temperature and weather. The warm weather prevailing in March was interrupted by an infiltration of cold air currents on April 4th. The second half of the month, however, was marked by a period of dry, sunny weather with large differences between day and night temperatures. There was also an interchange of summer weather and cold spells during the month of May.

This was followed by a period of heavy rainfall (June, July, August), which accompanied by relatively high temperatures offered excellent conditions for growing.

The weather during Autumn was marked chiefly by a period of high pressure, i. e. a succession of fine weather spells interrupted at intervals by days of light rainfall.

The graph showing the temperatures and rainfall in the district of Bergheim during 1953 (Fig. 5) can be taken as giving the average values for the weather conditions prevailing in the Grevenbroich-Bergheim-Cologne area where the controls were carried out.

Monthly average air temperatures in °C and rainfall in mm, 1953
Meteorological Station at Elsdorf, District of Bergheim, Rhineland

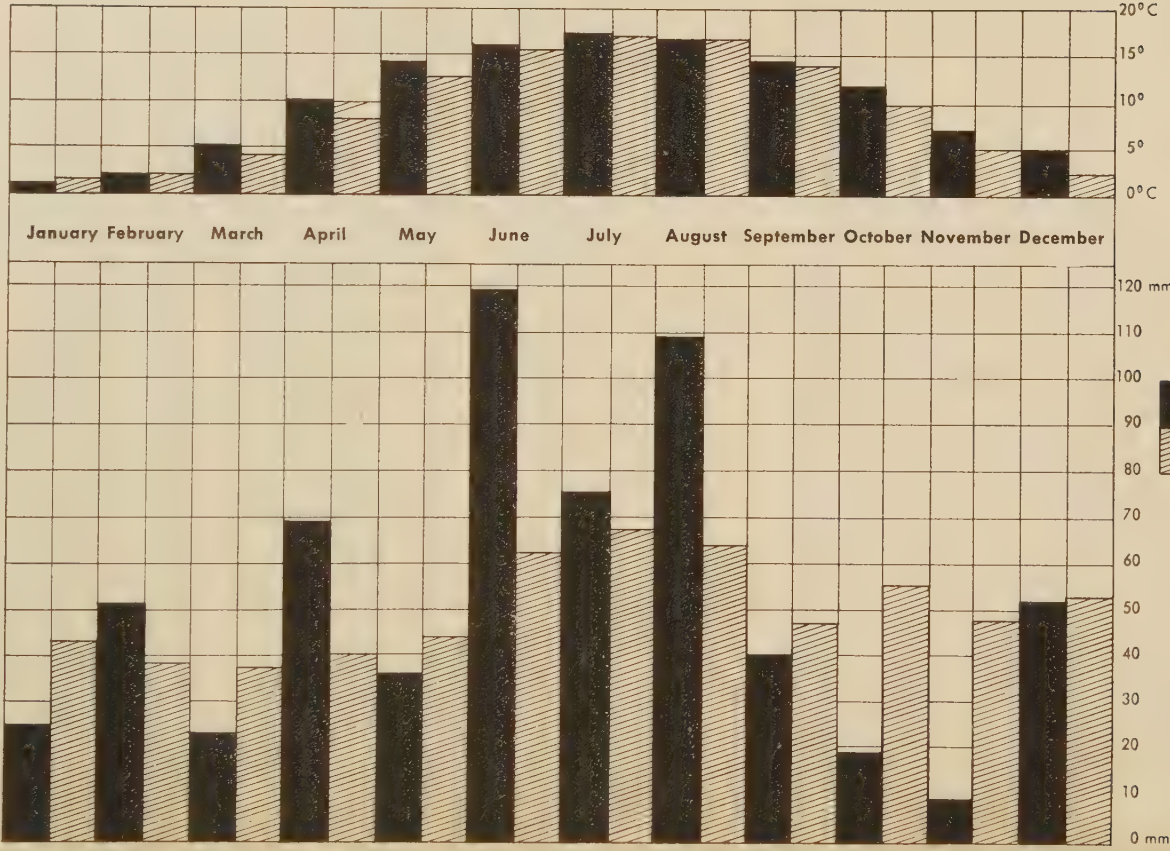


Fig. 5

Flight of *Myzus persicae* from peaches in different Rhenish warning service districts 1953

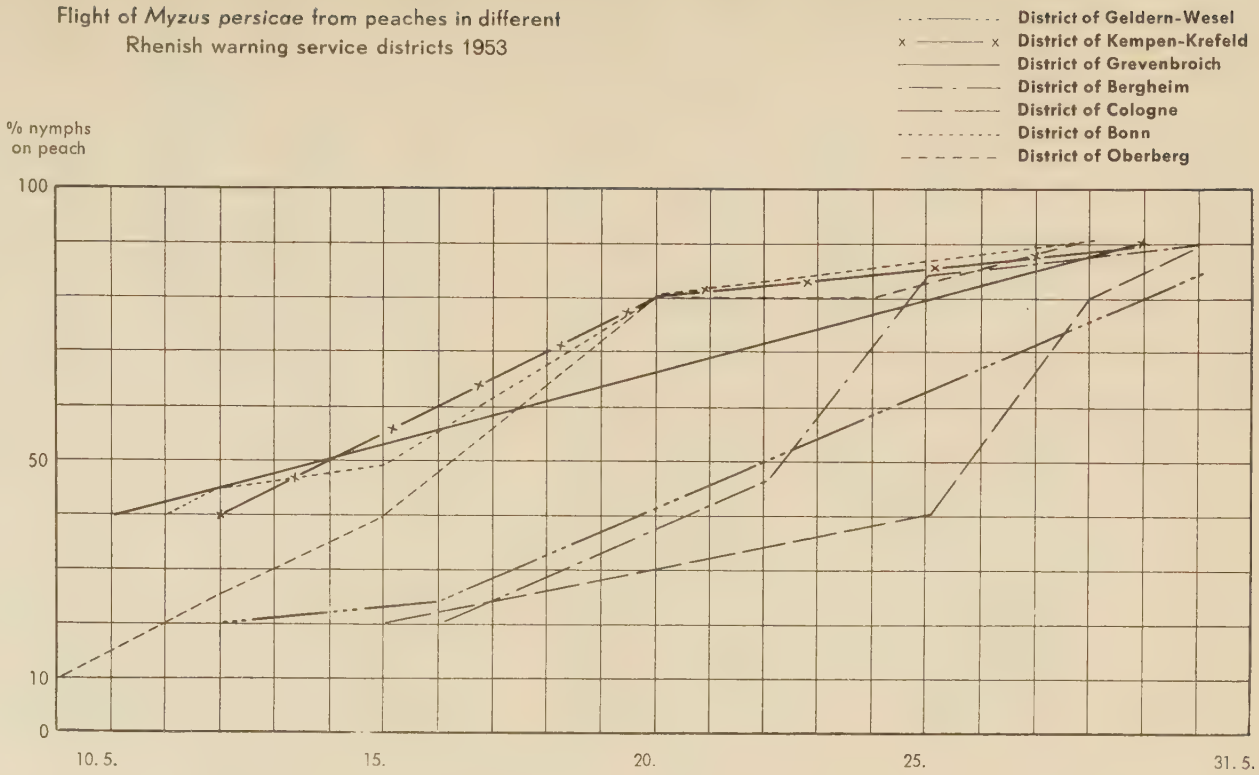


Fig. 6

The vegetation period of sugar beets was considerable prolonged by the early spring weather. Apparently the good yields are to be attributed to the summer rainfall, while the sunny autumn weather was responsible for increasing the sugar content. The favourable vegetation conditions in 1953 greatly influenced the occurrence of yellows.

b) Aphid development on primary and secondary winter hosts

Despite the very small numbers of eggs, there was an extremely high percentage — compared with past years — of fundatrices, hatched out during February, on the winter hosts of *Myzodes persicae* (peach) and *Doralis fabae (Evonymus europaeus* and *Viburnum opulus).* Therefore, the percentage of damaged eggs must have been low. The dry, warm weather during March (cf. Fig. 5) favoured the development of the aphids on the winter hosts so that fundatrices already fully grown were to be found by the beginning of April, followed by nymphs — and in certain cases insects ready to fly — during the last few days of April. It was, therefore, expected that the insects would take wing during the first few days of May. Such advanced development at an early stage in the year had only been previously observed in 1950 and 1952, that is to say within recent years.

During the first few days of May, relatively cool, moist weather set in quite unexpectedly with the result that the aphid development came to a standstill. Numerous ladybirds and syrphus flies, evidently not disturbed in their development by the weather, also carried out decimating attacks on the aphids further affecting the development of the latter.

The spindle trees were infested by ermine moths *(Hyponomeuta evonymella* and *H. padella)* so that in the end there were very few aphids on the wing by May 10th. The winged stage reached its climax at the end of the month (see Fig. 6).

c) Aphid gradation on sugar beets

Following a dissipated flight from their winter hosts, the further development of the virus vectors was decisively influenced by the wet weather which set in during the months of June and July (see Fig. 5).

The colonization of the beets made hesitating progress. By the end of May, the infestation density of *Myzodes persicae* throughout the whole of Rhineland amounted — with hardly any differences — to 0·03 to 0·07 aphid per plant. During the first few days following June 8 (see Fig. 7), there was a rapid reproduction of aphids which made it necessary to start immediate preparations for carrying out the first spray. It was then that the first differences in infestation density were made manifest within the area under observation. In the North-West the figures increased more rapidly (Geldern-Wesel) and to higher levels (Grevenbroich) than in the South-East of Rhineland (Bergheim, Bonn).

The progress of *Doralis fabae* colonization was more or less parallel to that of *Myzodes persicae,* although with higher values per plant (Fig. 8). During the time when the summer aphids occurred from May 20 to the end of July, 1953, there was an average rainfall of 221 mm, e. g. in the district of Bergheim, which greatly reduced the formation of colonies of vectors on the beets as compared with the previous year (see Fig. 9). As a result of the vigorous leaf

Fig. 7

Temporal progress of aphid infestation, *Myzodes persicae*, on sugar beets in different districts of Rhineland

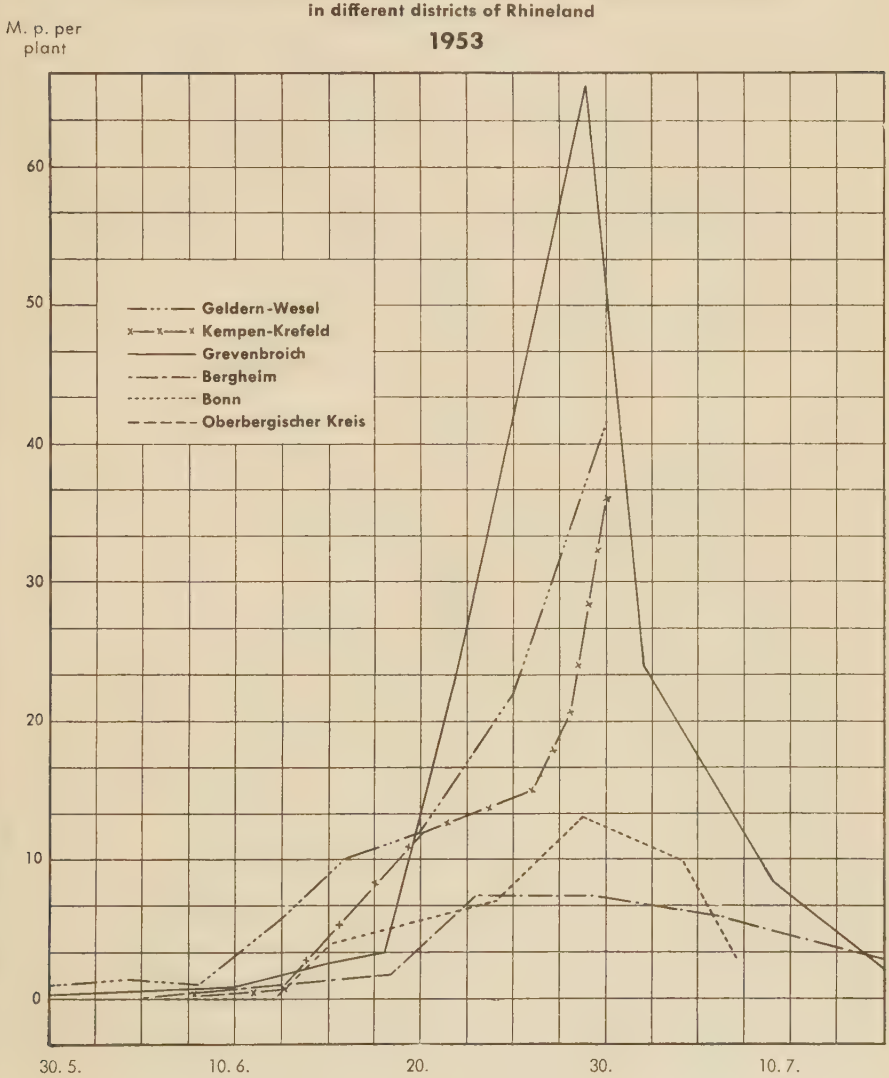
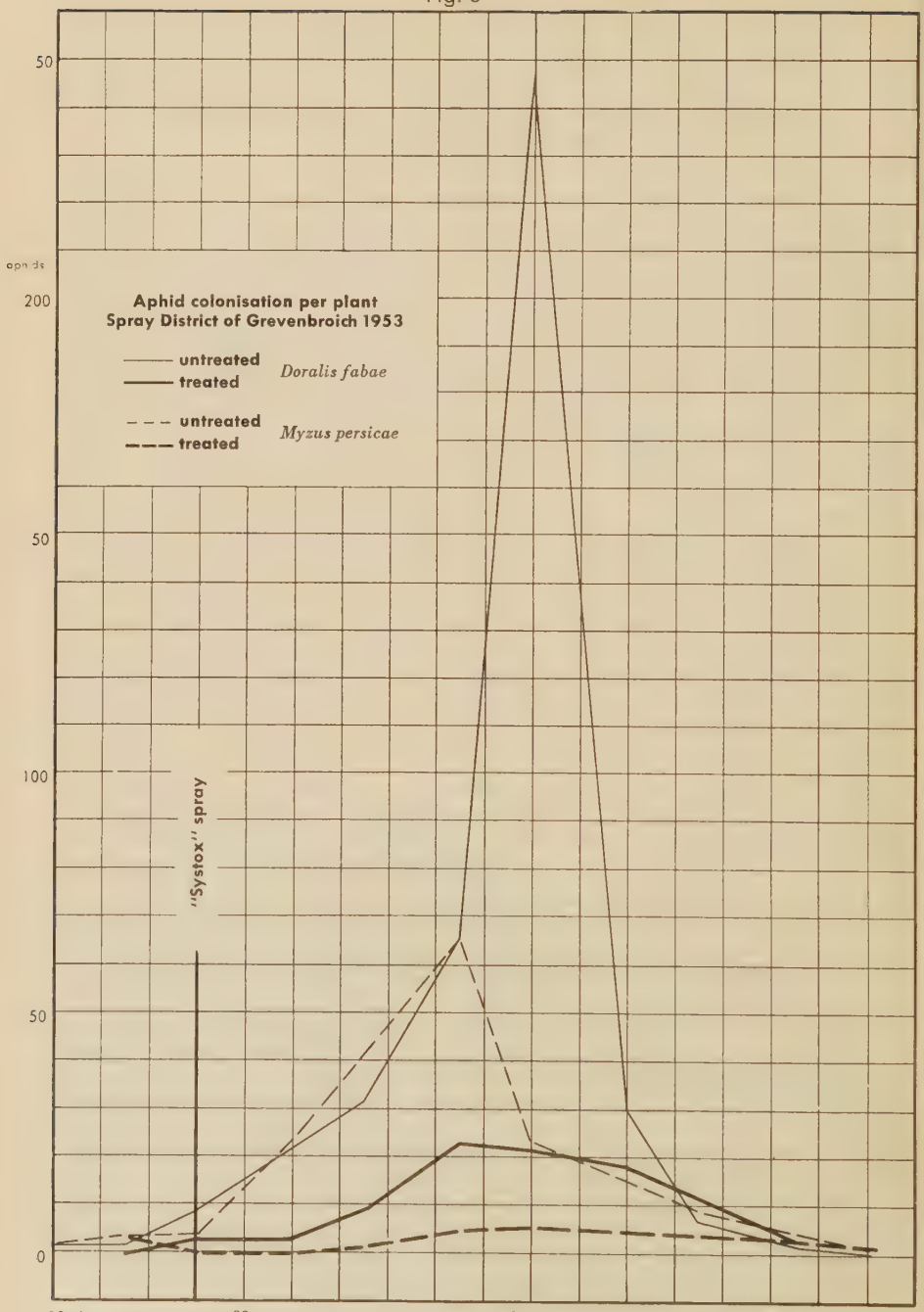


Fig. 8


aphids
50
200
50
100
50
0
Aphid colonisation per plant
Spray District of Grevenbroich 1953
untreated
treated
Doralis fabae
untreated
treated
Myzus persicae
"Systox" spray
12. 6.
20.
1. 7.
10.
15.

development of the beets, there was no further colonization even by the second flight which started in the latter part of June and reached its climax at the end of June to the beginning of July (as in 1952). The population collapsed during the last few days in July.

Close relations exist between the extent of the aphid colonization and the development stage of the beets. All the factors which promote the growth of the plants — be it the early start of tilling, abundant supplies of nutritive substances to the soil, favourable weather during the early stages of development — contribute to a suppression of the epidemics. Another important factor is that there is a large number of plants (80,000 per hectare). Under such conditions, a dense blanket of plants is formed much more quickly, preventing the virus vectors from settling.

In 1953, the farmers in Rhineland were able to till practically 50 % of the beet fields by the end of March, and the rest of the seed was sown by the first half of April at the latest. This was followed by a period of good growing conditions favourable to the development of the early stages so that the plants were growing densely early on in the season.

This meant that in 1953 the initial conditions for the development of the beets were ideal, whereas on the other hand they were unfavourable for the development and reproduction of the virus vectors.

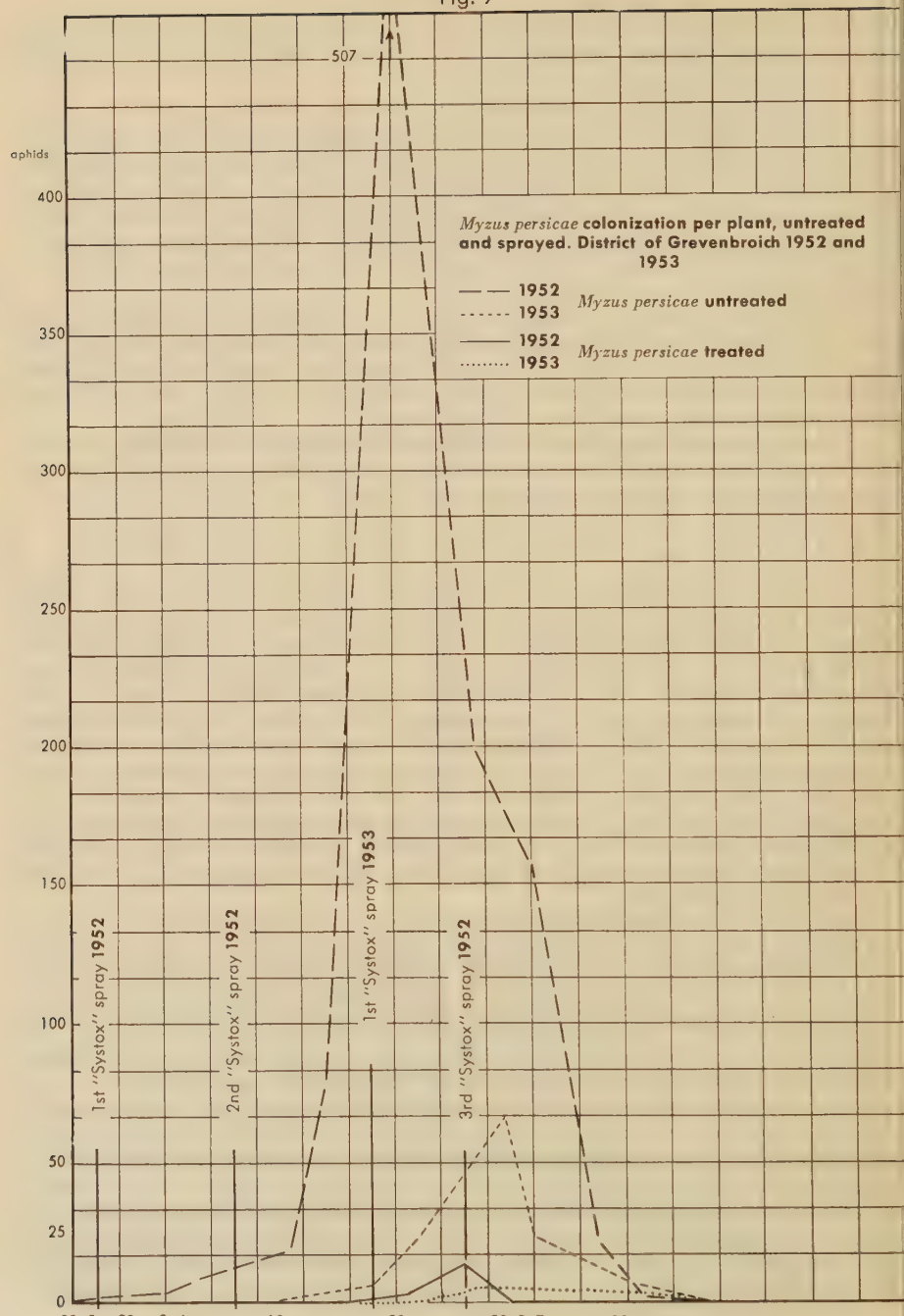
d) Effect of the "Systox" spray on the progress of the aphid gradation

It was not possible to forecast aphid occurrences and virus damage until the date for carrying out sprays was drawing very close. The first spray must always be applied more or less as a prophylactic measure, namely at the end of the main flight of migrants when there is an average colonization of beets amounting to 0·5 to 1 aphid of the *Myzodes persicae* species per plant. The treatment does not prevent the transmission of the yellow virus since the virus vectors continue to settle constantly on the plants, and the time needed to exterminate the aphids is longer than that required by the infection to take root. The virus damage is merely reduced, and the secondary propagation in the stock is kept in check to a large extent by eradicating the wingless aphids. An important factor for the long-lasting effect of "Systox" is that the beets or the leaves have reached a well advanced stage of development at the time the spray is carried out.

At the time the "Systox" sprays were carried out from June 15 to 25, 1953, the beets had already reached the desired advanced stages of growth. There was, however, cause for concern due to the frequent rainfall since it was feared that the spray wash would not become effective should rain actually set in while the sprays were being carried out. The test report 1952 on Page 165 does however reveal that the effect of the spray wash is guaranteed provided there is no rainfall for at least 30 minutes following the application.

Fig. 10 shows that the exterminating effect of "Systox", both in the heavily colonized beet growing district of Grevenbroich and in the districts of Cologne and Bergheim, was most satisfactory, reducing development of aphids to a minimum. At the most, 7 *Myzodes persicae* per plant on "Systox" treated beets developed on the average in all the fields examined, i. e. the colonization maximum for *Myzodes persicae* in sprayed stocks in the Grevenbroich area was only 8·6 % of that in the untreated fields, and in Bergheim 38·4 %. This reveals that the exterminating effect of the preparation, expressed as a percentage, is

Fig. 9


507
aphids
400
350
300
250
200
150
100
50
25
0
Myzus persicae colonization per plant, untreated and sprayed. District of Grevenbroich 1952 and 1953
1952
1953
Myzus persicae untreated
1952
1953
Myzus persicae treated
1st "Systox" spray 1952
2nd "Systox" spray 1952
1st "Systox" spray 1953
3rd "Systox" spray 1952
22. 5.
30.
2. 6.
10.
20.
30.
2. 7.
10.

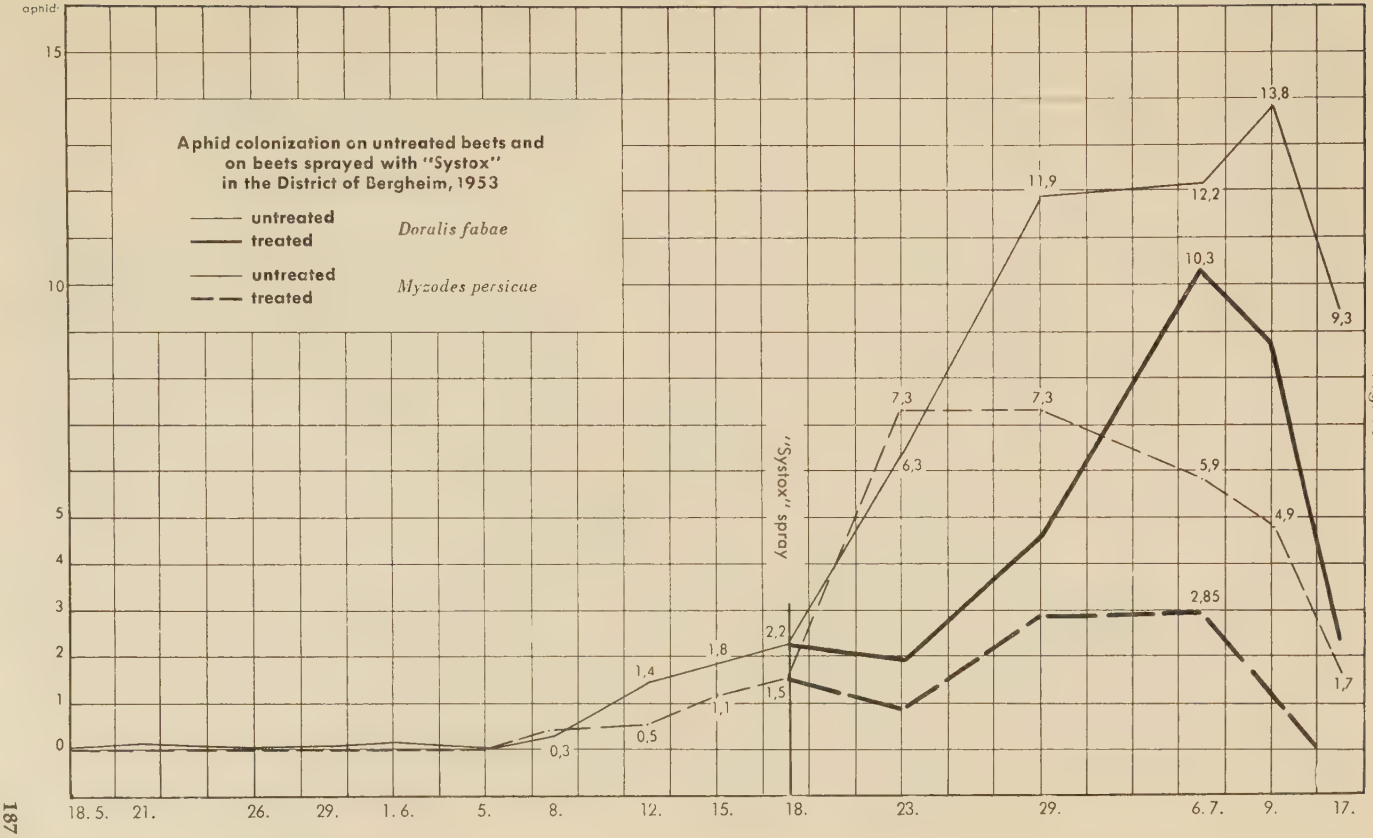

aphid
15
10
5
4
3
2
1
0
Aphid colonization on untreated beets and on beets sprayed with "Systox" in the District of Bergheim, 1953
untreated
treated
Doralis fabae
untreated
treated
Myzodes persicae
"Systox" spray
13,8
12,2
11,9
10,3
9,3
7,3
7,3
6,3
5,9
4,9
2,85
2,2
1,8
1,7
1,5
1,4
1,1
0,5
0,3
18. 5.
21.
26.
29.
1. 6.
5.
8.
12.
15.
18.
23.
29.
6. 7.
9.
17.

Fig. 10

greater when there is a dense population of aphids. (The colonization in the district of Grevenbroich was eight times greater than in Bergheim.)

Following the satisfactory results produced by the first "Systox" spray, the initial population of aphids on the beets was reduced considerably. Due to extremely vigorous growth of the beets during the second attack by summer aphids, there was no further colonization worthy of note so that it was not necessary to carry out the second "Systox" treatment already planned.

e) Appraisement of symptoms

As a result of the favourable growing conditions that prevailed in 1953 and the weak infestation of the beets by aphids, only one "Systox" spray was carried out.

The decision to restrict the treatment to only one spray proved to be justified since the continuous rainfall in June delayed the start of the spray so much that the second spray would have been due more or less at the time when the summer gradation collapsed. On the other hand the summer flight in 1953 did not lead to any large increase in the infestation density since the beets were already growing in dense stocks by the time the aphid winged stage had reached its climax. Consequently the degree of infection was too low to illustrate clearly the differences between the symptomatic values as reduced by "Systox" and those of the untreated fields.

The first characteristics of the disease were perceived at the end of June, and at the beginning of July the otherwise green stocks were marred by yellow infection centres lying close to each other. The symptoms, however, were often so unspecifically marked that they could not always be regarded with certainty as virus symptoms, and were therefore underestimated. (Aphid yellows caused by poor supply of magnesium to the plants was often mistaken for virus yellows.) In the district of Grevenbroich the investigation was affected for a short period due to several of the fields under observation being heavily damaged by hail on July 25.

A start was made at the end of July in all the districts sprayed, with the weekly evaluation of the beet stocks scattered about the area to determine in percentage their infestation of yellows and the degree of symptoms. For this purpose sprayed fields were selected which, with respect to their development, corresponded somewhat to the average of the entire area, and which wherever possible were located close to unsprayed fields in the same stage of development. The degree of infection in the adjacent fields could, with more or less complete certainty, be assumed to be the same as the sprayed fields, so that it was possible to register the extent to which the "Systox" sprays had either delayed or prevented the infection. Since it was not known what cultivation work had previously been carried out in the fields, only a large number of investigations in the case in question could lead to comparable values.

In the Cologne district 10 sprayed and 6 untreated beet fields were taken, in Grevenbroich 8 sprayed and 8 untreated, and in Bergheim 11 sprayed and 6 untreated. 200 plants in each were classified from 0 to 5 as follows:

0 = no visible symptoms of yellows
1 = very weak symptoms of yellows
2 = weak symptoms of yellows
3 = medium symptoms of yellows
4 = serious symptoms of yellows
5 = very serious symptoms of yellows

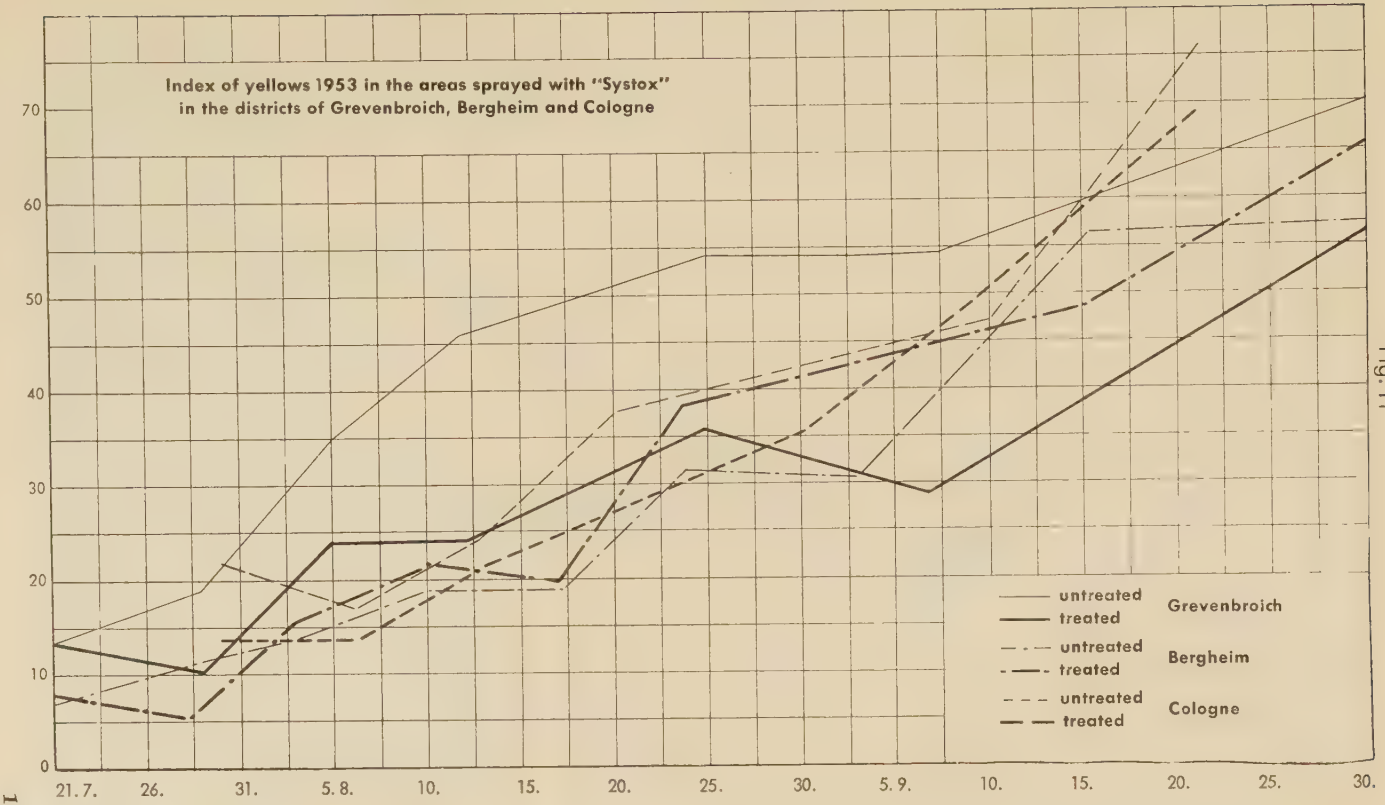

Index of yellows 1953 in the areas sprayed with "Systox"
in the districts of Grevenbroich, Bergheim and Cologne
70
60
50
40
30
20
10
0
21.7.
26.
31.
5.8.
10.
15.
20.
25.
30.
5.9.
10.
15.
20.
25.
30.
untreated
treated
Grevenbroich
untreated
treated
Bergheim
untreated
treated
Cologne

Fig. 11

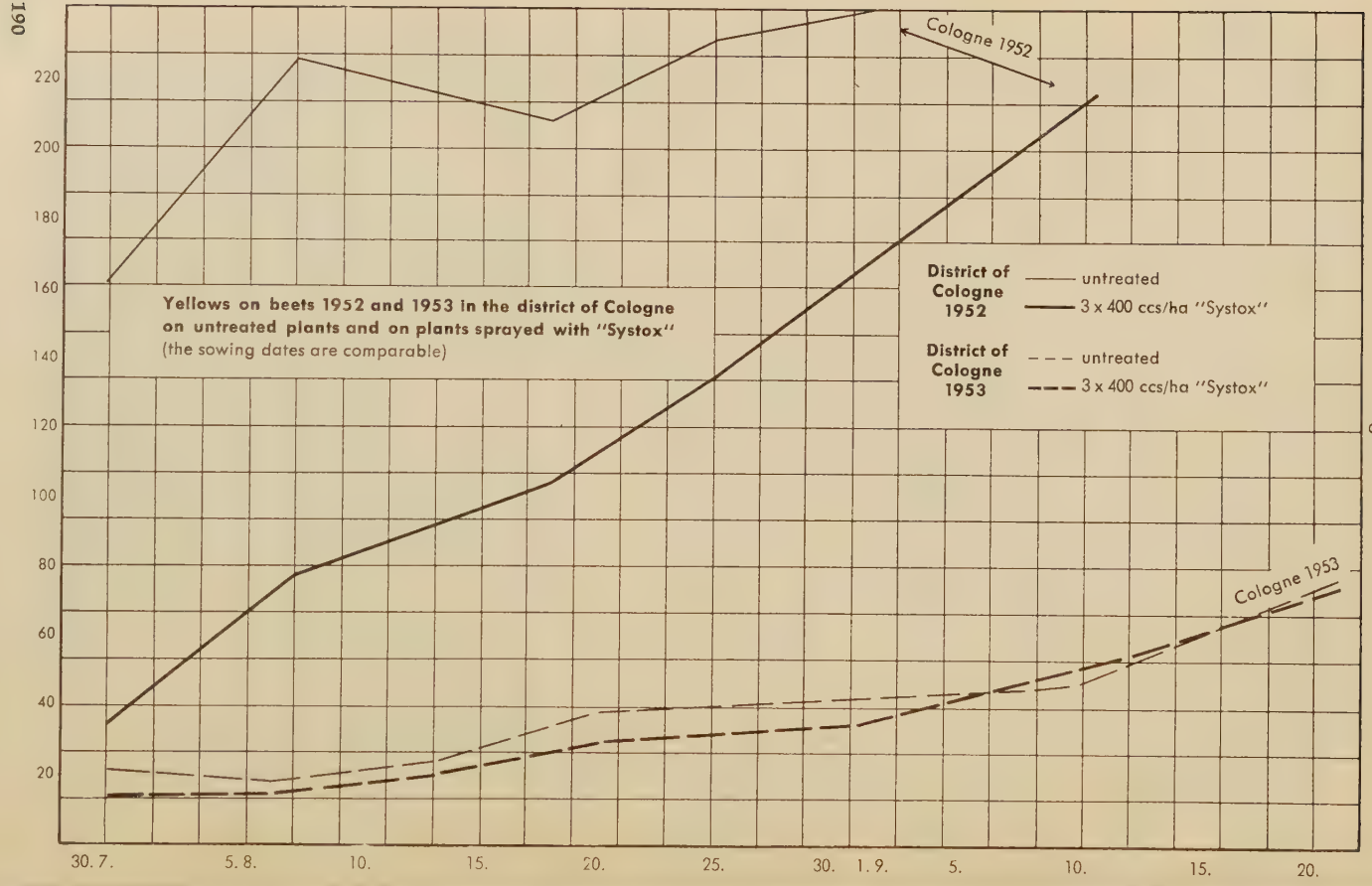

Cologne 1952
Cologne 1953
Yellows on beets 1952 and 1953 in the district of Cologne
on untreated plants and on plants sprayed with "Systox"
(the sowing dates are comparable)
District of Cologne 1952
untreated
3 x 400 ccs/ha "Systox"
District of Cologne 1953
untreated
3 x 400 ccs/ha "Systox"
220
200
180
160
140
120
100
80
60
40
20
30. 7.
5. 8.
10.
15.
20.
25.
30.
1. 9.
5.
10.
15.
20.

Fig. 12

A picture of the progress of the yellow disease (infestation index) (see Fig. 11 and 12) is obtained by multiplying the degree of yellows expressed as a percentage by the degree of symptoms found — each value is an average for the numbers of the fields given. At the start of the evaluation towards the end of July, the degree of yellows for all three districts was 8·4 % for treated fields and 13·9 % for untreated fields, with a degree of symptoms on diseased plants amounting to 1·16 in the treated fields and 1·25 in the untreated fields. At the same time in the previous year, the untreated stocks were 100 % diseased, and those sprayed with "Systox" 65 % infected. During August the degree of yellows in the sprayed area increased to 30 % with medium to weak symptoms.

The curves in Fig. 11 confirm, inter alia, the following observations made by S t e u d e l : the yellow disease occurs earlier and more intensively in the North West of the Rhenish beet growing area than in the South Eastern part of this area. The same is the position in the district of Grevenbroich. The "Systox" sprays carried out from June 15 to 25, 1953 in this district reduced the initial population which would eventually have led to a mass colonization in summer to such an extent that the infections were only very weakly effective thus resulting in a most obvious difference in the degree of symptoms as compared with the untreated beet fields.

On the other hand the sharp rise of the yellows curve on September 1, 1953 in the Cologne district, situated in the South East, shows that late infections occurred in this district which probably could have been avoided by carrying out a second "Systox" spray — or at least by a later "Systox" spray — provided that they occurred as the result of a strong development of the population following the first spray. In all probability, however, the late infection could have had no considerable yield-reducing effect because the foliage of the beets, which in this particular year was strongly developed, reacts more slowly and more weakly to an infection since the virus has a much larger leaf area to infect, and consequently sufficient foliage is left which is still able to grow vigorously and to help the plant to overcome the consequences of the infection more rapidly. In view of these facts it was deemed uneconomical to carry out a second spray as already planned.

The situation is quite different when the beet seeds are not sown early enough because of a late spring, and when the following growing conditions are unfavourable. As a result the plants are still relatively young when the summer reproduction of aphids begins. Moreover the aphids prefer to settle on young plants — resulting in a dense population — which suffer much more than older plants from a virus infection. These unfavourable conditions were prevalent in certain parts of the Cologne district where there was an unusually heavy downpour of rain on April 3 (Good Friday) which destroyed beet seeds as they were just in the process of emerging or germinating, thus rendering it necessary to plough up the soil and to sow a second time. The consequences of this were later made manifest by a heavy degree of infestation. From exact tests carried out in the district of Grevenbroich it can be concluded that also in 1953 the high degree of yellow disease is based on a greater sensitivity of young plants and on an increased population development.

In the district of Bergheim there were no considerable differences between untreated and treated fields with respect to the degree of yellows symptoms. These general field observations are consistent with results obtained on half-sprayed and half-unsprayed fields (in this case assistance was given by the

sugar factory at Elsdorf). From these results, comparable values are obtained since the pre-conditions were the same. Apart from the field observations, several samples were also lifted.

Herr Dr. Krüger, head chemist of the sugar factory of Pfeifer & Langen in Elsdorf, kindly examined the samples, but reserves the right to publish these figures.

From the following polarisation results

Date	% Polarisation	
	untreated	treated
September 19	16·3	16·7
September 26	16·7	17·0
October 3	16·8	17·1
October 8	17·0	17·0

it is obvious that the untreated beets had a low sugar content when the first samples were taken, but that they had recovered by the end of the vegetation period as the result of favourable weather conditions and an absence of late infections. From the few investigations carried out it could not be determined whether the initial high values of treated beets are to be attributed to the effect of populations or to a reduction of the virus damage by "Systox". Even the evaluation figures for these fields reveal differences at the beginning although these are also balanced out during the course of the vegetation period.

Table 10

	Appraisement on	%yellow-infected plants	Degree of symptoms diseased plants	%yellow-infected plants	Degree of symptoms diseased plants
		untreated		sprayed	
No. 1. District of Bergheim	Aug. 17	15·0	1·63	11·2	1·85
	Aug. 28	20·0	1·82	21·6	1·86
	Sep. 19	34·2	2·53	31·4	2·27
No. 2. District of Bergheim	Aug. 17	8·4	1·46	2·0	2·00
	Aug. 28	11·6	1·47	7·5	1·92
	Sep. 19	20·0	2·20	18·0	1·83
No. 3. District of Bergheim	Aug. 17	11·0	1·91	7·5	1·40
	Aug. 28	17·9	1·86	12·6	1·42
	Sep. 19	22·8	2·22	23·1	1·70
No. 4. District of Grevenbroich	Aug. 27	16·0	1·37	7·0	1·21
	Sep. 18	27·0	1·72	23·1	1·43
No. 5. District of Grevenbroich	Aug. 27	6·5	1·61	12·0	1·37
	Sep. 18	15·4	2·08	25·2	1·97
No. 6. District of Bergheim	July 23	6·5	1·08	3·5	1·00
	July 28	16·3	1·33	4·0	1·12
	Aug. 3	14·8	1·40	13·4	1·12
	Aug. 17	27·0	1·70	24·3	1·33

A phenomenon of importance for beet cultivation in the district of Bergheim was the late occurrence of *Cercospora* which could by no means be referred to as an infestation of a secondary nature. Since the dry weather in the Autumn prevented the growth of new leaves on the beets which had already reached an advanced stage of development, the damage only affected the foliage and not the beet and sugar yield. This was not so serious from an economical point of view seeing that the situation in respect of cattle fodder was most favourable in this particular year.

In order to judge properly the evident success of the "Systox" control, it was necessary to inspect the beet stocks growing outside the sprayed area. Therefore, Dr. Steudel made a number of trips from the 6th to the 9th of September, 1953 solely for this purpose. A particular feature was that the farther north one travelled, i. e. towards the Lower Rhine, the greater was the percentage of yellows, and in fact north of Krefeld the value established was 100 %. Beet stocks located on the right bank of the Rhine in a line with Krefeld were just as much infected as those fields lying on the left bank (see Fig. 13). Even in the direction of the western border there was an increasing tendency towards yellows infection, probably due to the predominant cultivation of fodder beets. The symptoms could be described everywhere as being moderate to serious. The region immediately adjoining the sprayed area, i. e. the districts of Duesseldorf-Mettmann and Erkelenz, practically represented a region of transition. The infection density here was between 50 and 60 %. Despite this high percentage of infection, no high yield and polarisation losses are to be expected due to the late occurrence of yellows, favourable growing weather, and an advanced stage of beet development. The following details in respect of climate prove that the months of October and November, 1953 in particular were far warmer and drier than in previous years. The diseased beets merely needed more moisture to develop new leaves, whereby a drop in the sugar content was avoided.

September:	40·0 mm rainfall	= 83 %	of the mean for several years	
October:	19·0 mm „	= 34 %	„ „ „ „ „ „	
November:	8·4 mm „	= 18 %	„ „ „ „ „ „	
September:	14·6 ° C daily mean	= approx.	+ 0·6 to + 1·0	deviation from the mean for several years
October:	11·8 ° C „ „	= „	+ 2·5 to + 3·0	
November:	7·2 ° C „ „			

An estimate of the success of the control measures based on the field evaluation leads to incorrect results since the outward appearance of the disease need not correspond to the damage inflicted.

On the other hand, a question of particular interest was whether the single spray carried out in the three rural districts of Cologne, Grevenbroich and Bergheim had led to an increase in the yield of sugar beets. In order to determine this, it would be necessary to obtain the assistance of the sugar factories in these areas. Owing to the accumulation of a large number of results, it would probably not be necessary to make allowances for the other factors which influence the yield, such as previous crops, fertilisation, tilling, and cultivation, in order to clearly recognise the effect of "Systox". However, an increase in yield as the result of an application of "Systox" is not less likely

Fig. 13

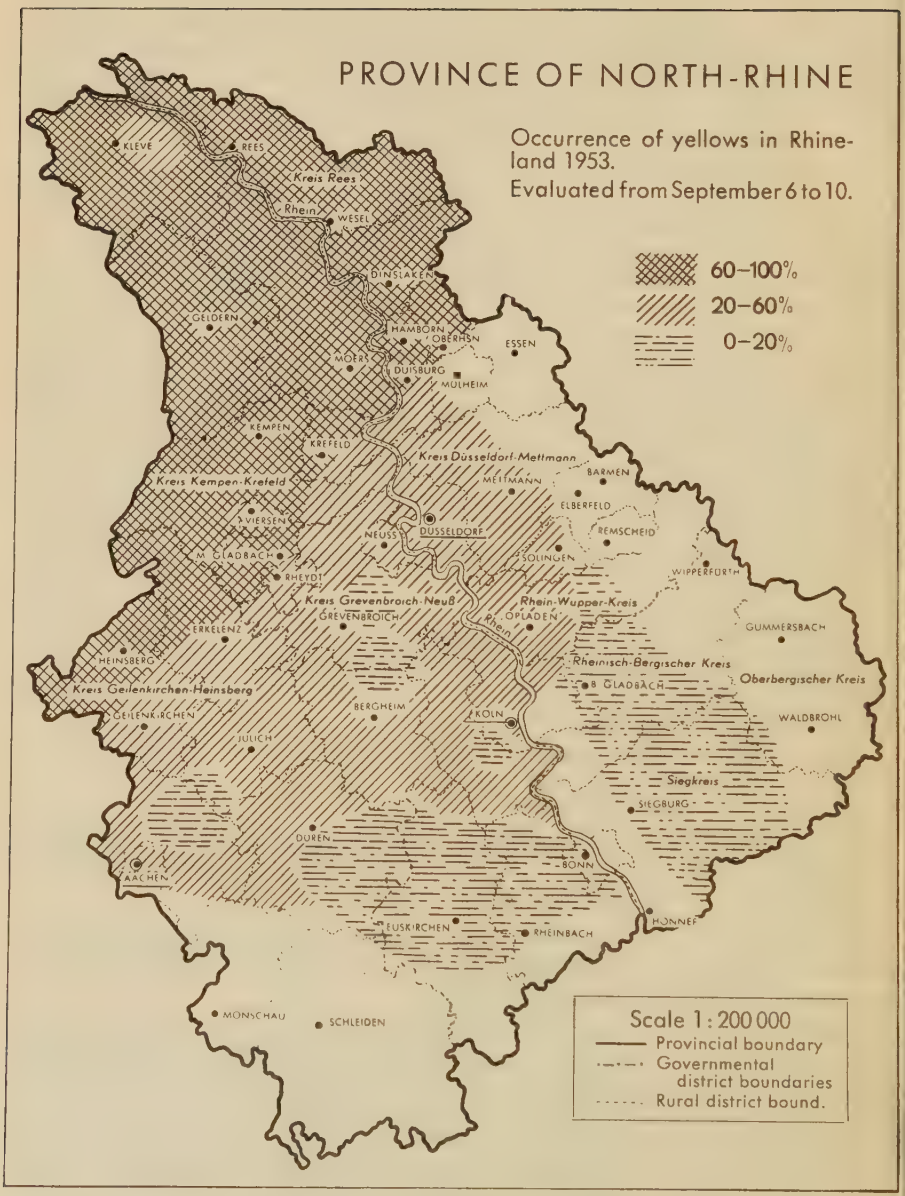

PROVINCE OF NORTH-RHINE
Occurrence of yellows in Rhineland 1953.
Evaluated from September 6 to 10.
60–100%
20–60%
0–20%
KLEVE
REES
Kreis Rees
Rhein
WESEL
DINSLAKEN
GELDERN
HAMBORN
OBERHAUSEN
ESSEN
MOERS
DUISBURG
MULHEIM
KEMPEN
KREFELD
Kreis Düsseldorf-Mettmann
Kreis Kempen-Krefeld
MEITMANN
BARMEN
ELBERFELD
VIERSEN
NEUSS
DÜSSELDORF
REMSCHEID
N. GLADBACH
RHEYDT
SOLINGEN
WIPPERFÜRTH
Kreis Grevenbroich-Neuß
GREVENBROICH
Rhein-Wupper-Kreis
OPLADEN
Rhein
GUMMERSBACH
ERKELENZ
HEINSBERG
Kreis Geilenkirchen-Heinsberg
Rheinisch-Bergischer Kreis
Oberbergischer Kreis
BERGHEIM
KÖLN
WALDBRÖHL
GEILENKIRCHEN
JÜLICH
Siegkreis
SIEGBURG
DÜREN
BONN
AACHEN
EUSKIRCHEN
RHEINBACH
HONNEF
MONSCHAU
SCHLEIDEN
Scale 1 : 200 000
Provincial boundary
Governmental district boundaries
Rural district bound.

Table 11: Yields of treated and untreated sugar beet fields in the area of the large-scale "Systox" control carried out in Rhineland in 1953 (according to information supplied by the sugar factories at Wevelinghofen, Elsdorf and Dormagen).

			Beets 100 kg/ha	Polarisation in %	Sugar dz/ha	Area ha	Area %	No. of growers	Price according to polarisation	Price in DM/ha
1	Grevenbroich	untreated	428·24	15·80	67·66	1848·8	100	982		
		treated	470·44	15·84	74·52	1576·0	85·2	613		
		change due to "Systox"	+ 42·20	+ 0·04	+ 6·86 = 10·14 %					
2	Bergheim	untreated	419·60	16,04	67·30	786·2	100	347		
		treated	454·92	16,20	73·70	701·8	89·3	254		
		change due to "Systox"	+ 35·32	+ 0·16	+ 6·40 = 9·51 %					
3	Cologne	untreated	386·62	15·78	61·01	331·1	100	115		
		treated	417·28	15·92	66·43	867·0	261·8	199		
		change due to "Systox"	+ 30·66	+ 0·14	+ 5·42 = 8·88 %					
	Average of the three districts	untreated	411·49	15·87	65·30	2966·1	100	1444	6·433 DM/dz	2647·12 DM
		treated	447·55	15·99	71·56	3144·8	106·0	1066	6·495 DM/dz	= 2906·84 DM
		change due to "Systox"	+ 36·06	+ 0·12	+ 6·24			2510		+ 259·72 = 9·8 %
										for 10 467·41 ha sprayed area = 2 718 595·73

Total sprayed area 10 467·41 ha = 100 %

Calculated sprayed area 3 144·8 ha = 30·04 %

A total of 2 671 955·36 metric tons of clean beets were taken for the calculation.

The 0·5 % polarisation (% of dirt) has been deducted.

in cases of slight yellows infection, late occurrence of the disease, and when the general conditions favour the growth of the beets. All the above-mentioned factors were existent in 1953.

5. Evaluation

As the result of extensive support given by the three "Pfeifer & Langen" sugar factories at

Wevelinghoven, in the control district of Grevenbroich
Elsdorf „ „ „ „ „ Bergheim
Dormagen „ „ „ „ „ Cologne,

it was possible to evaluate the beet yields and polarisations of 2500 suppliers, 50 % of whom had had the entire area of their beet fields treated with "Systox" (consideration was given only to the records of growers whose figures in Morgen — registered with the factory — corresponded with the area treated by the spraying team). The other growers had not taken part in the "Systox" control although their fields were located in the area sprayed. In this way 3144·81 hectares, i. e. 30 % and a beet yield of 2 671 955·36 metric tons, were recorded and evaluated out of a total area sprayed of 10 467·41 hectares (see Table 11).

Since it was not possible to investigate sufficient harvests in detail due to the large area included in the control, it was necessary to rely on statistical mass calculations. This method might leave much to be desired but on the other hand it is to be assumed that as a result of the large number of values available most of the uncertain factors are eliminated. Since the calculations for each district were made separately, and the results in the three districts are consistent, it is to be presumed that the uniform additional beet yields of the sprayed areas are to be credited to the control of the vectors. Moreover, exact tests carried out by Steudel from 1951 to 1953 provide confirmation of this.

The difference in yield is most marked in the district of Grevenbroich. This may be connected with the dense colonisation of aphids and high degree of yellows in this district — already discussed — which were most noticeably reduced by the treatment with "Systox". The high beet yields are actually due to the fertile loess soil which, when compared with other districts (e. g. Bergheim, Euskirchen), had always produced increased yields accompanied by low polarisations. As shown by the list of yields, the increased sugar yields in all three districts are not based so much on the high polarisations as upon the higher beet yields. The Cologne district, having the lowest yield differences. was checked statistically (variations) with respect to its beet yields per hectare; the calculations produced a reliable value of 0·25. That offers a good measure of security as regards tillage for the many preconditions of beet growing not consistent with each other.

In order to avoid any suspicion of having unwittingly selected special farms for the "Systox" sprays, a number of farms with beet growing areas exceeding 5 hectares were checked in a separate calculation. In this case too, considerable differences were established between sprayed and unsprayed fields:

Table 12: Farms with beet growing areas exceeding 5 hectares, relative figures

	No. of farms checked	100 kg/hectare beet yield
Grevenbroich		
untreated	100	100
treated	119	104·08
Bergheim		
untreated	100	100
treated	85·7	114·10
Cologne		
untreated	100	100
treated	381·8	123·30

In the calculation, the average yield increase for the three districts produced a profit of DM 259·72 hectare. The beet grower was left with a profit of DM 223·32/hectare after deducting spraying expenses of DM 36·40 per hectare (costs of the spray and wages for spraying teams). (These figures do not include costs for water supply and hiring charges for tractors, amortisation of equipment and provision of respirators. The exact assessment of these costs — with the exception of respirators — requires special investigation, and is not within the scope of these considerations. The establishment of a special aphid observation service as the first condition for such measures should be entrusted to the official Plant Protection Service, to begin with. The extent to which the costs incurred for maintaining such an observation service can be included in the total costs of the control measures, depends largely upon the organisation system of the competent Plant Protection Service).

The above result, obtained in a year when there was a weak occurrence of yellows, again furnishes evidence of the economy of carrying out a control with an insecticide.

Summary

The large-scale test carried out in 1952 was intended to clarify the question as to what extent past scientific knowledge can be applied to practical conditions. Before the test was started, it was fully realised that the lack of inconsistency between the single plots would influence a large-scale test. This meant, however, that conditions resembling those encountered in practice formed the basis for the implementation and evaluation of the test.

The early clearance of sites where the vectors picked up the virus — or an early control of the vectors on these sites — did not reduce the degree of infection to any considerable extent. In 1952 the conditions were in favour of a marked yellows year. Three sprays were carried out. The large scale test proved that even under practical conditions, chemical controls can be carried out successfully and economically.

In 1953, the occurrence of yellows was only slight (excellent conditions for beet development, yet unfavourable for the development and reproduction of virus vectors). In the districts of Grevenbroich, Bergheim and Cologne, 41 869·6 Morgen of sugar beets were treated once with "Systox". Participation of growers was voluntary. The Plant Protection Service was entrusted with the organisation and supervision of the control, and the fixing of the spraying date. It was arranged for the Association of Orchard and Plant Protection Wardens to carry out the sprays. Eight cases of intoxication occurred. The control measures were evaluated by observing the colonization of sugar beets by aphids, appraisement of the symptoms both in the stock as well as by means of a statistical mass calculation of the yields. The result of the test again proved, even in a year when there was a weak occurrence of yellows, the economy of a chemical control of virus vectors on the beets.

References

Ernould, L.:
Lutte contre la jaunisse de la betterave. Etude de l'action d'insecticide « systemiques » en champs d'essays au cour des années 1951/1952. Extroit des Publications Techniques de l'I. R. A. B. 2, 1952, 41

Heiling, A.:
Der Einfluß der Vergilbungskrankheit auf den Ertrag der Rüben. (The influence of yellows on beet yields.) Zucker 6, 1953, 27—33.

Hull, R.:
Assessments of losses in sugar beet due to virus yellows in Great Britain 1942—1952.
Plant Pathology 2, 1953, 39—43.

Klinkowski, M., and U. Sedlag:
Ein Beitrag zur Epidemiologie und Prophylaxe der Vergilbungskrankheit der Beta-Rüben. (A contribution to the epidemiology and prophylaxis of yellows on beta beets.)
Nachrichtenblatt für den Deutschen Pflanzenschutzdienst 7, 1953, 7—12.

Lüdecke, H., and O. Neeb:
Untersuchungen über den Einfluß von Gelbsuchtvirusinfektion auf physiologische Gradienten der Zuckerrübe. (Investigations into the influence of virus yellows on physiological gradients of sugar beets.)
Zucker 6, 1953, 117—120.

Lüdecke, H., and M. Nitzsche:
Beitrag zur Frage nach dem Einfluß der Düngung auf Ertrag und Beschaffenheit der Zuckerrüben bei der virosen Vergilbung. (Contribution to the question concerning the influence of fertilization on yields and the state of the sugar beets when infested by yellows.)
Zucker 5, 1954, 206—214.

Rietberg, H.:
De Vejelungsziekte der bieten. (Yellows of beets.)
Med. Inst. Suikerproduktie 21, 277—291.

Schlösser, L. A.:
Zur Frage der Wanderung europäischer Rübenvirosen.
(Migration of European beet viruses.)
Phytopatholog. Zeitschr. 20, 1953, 75—82.

Sedlag, U.:
Untersuchungen über den sommerlichen Massenwechsel der Vektoren der virösen Rübenvergilbung in Mitteldeutschland. (Investigations into the summer mass migration of vectors of virus beet yellows in Central Germany.)
Nachrichtenblatt für den deutschen Pflanzenschutzdienst 7, 1953, 161—168.

Steudel, W.:
Über Auftreten und Ausbreitung der virösen Rübenvergilbung im Elsdorfer Versuchsfeld und ihre Beziehungen zum Massenwechsel der Überträger in zwei Extremjahren.
(Occurrence and propagation of virus beet yellows in the Elsdorf experimental area, and the relationship to the mass migration of the vectors in two extreme years.)
Nachrichtenblatt der Biol. Zentralanst. Braunschweig, 1, 1949, 166—171.

—
Über die Bedeutung einiger winterfester Gemüsesamenkulturen als Winterwirte der grünen Pfirsichblattlaus in der Kölner Bucht. (The significance of several winter-resistant vegetable seed cultures as the winter hosts of the green peach aphid in the Cologne area.)
Nachrichtenblatt des Deutschen Pflanzenschutzdienstes, Braunschweig, 2, 1950, 70—74.

—
Verbreitung und Epidemiologie der Vergilbungskrankheit und heutiger Stand der Bekämpfung. (Propagation and epidemiology of yellows, and the present levels of control.)
Zucker 4, 1951, 181—185.

—
Untersuchungen zur anholozyklischen Überwinterung der grünen Pfirsichblattlaus an Brassicaceen. (Investigations into the anholocyclic overwintering of green peach aphids on Brassicaceae.)
Mitteilungen a. d. Biol. Zentralanst. Berlin-Dahlem, 73, 1952.

—
Zur Frage der Bekämpfung der Vergilbungskrankheit der Beta-Rüben durch Überträgerabtötung mit chemischen Mitteln. (The control of yellows on beta beets by eradicating the vectors with chemical preparations.)
Zeitschr. f. Pflanzenkrankheiten 59, 1952, 418—429.

—
Epidemiologische Studien zur Vergilbungskrankheit im Rheinland 1952. (Epidemiological studies of yellows in Rhineland, 1952.)
Zucker 6, 1953, 69—73.

—
Sind wir gegen die Vergilbungskrankheit der Rüben immer noch machtlos? (Are we still powerless against yellows of beets?)
Mitteilungen d. D. Landw. Ges. 2. 1954.

Steudel, W., and F. Burckhardt:
Zur Überwinterung der grünen Pfirsichblattlaus in westdeutschen Futterrübenmieten. (Overwintering of green peach aphids in stacks of fodder beets in Western Germany.)
Nachrichtenblatt d. D. Pflanzenschutzdienst., Braunschweig, 2, 1950, 137—138.

Steudel, W., and A. Heiling:
Über die Verbreitung der Vergilbungskrankheit und des Mosaiks der Beta-Rüben in Westdeutschland. (Propagation of yellows and the mosaic of beta beets in Western Germany.)
Zeitschr. f. Pflanzenkrankheiten 56, 1949, 380—385.

—
Der Einfluß der Saatzeit auf Auftreten und Ausbreitung der Vergilbungskrankheit der Beta-Rüben. (The influence of the sowing date on the occurrence and propagation of yellows of beta beets.)
Nachrichtenblatt d. D. Pflanzenschutzdienstes, Braunschweig, 4, 1952, 40—44.

—
Die Vergilbungskrankheit der Zuckerrüben. (Yellows of sugar beets.)
Mitteilungen der Landw. Ges. 67, 1952, 392—393.

—
Die Vergilbungskrankheit der Rübe. (Yellows of beets.)
Mitteilungen aus der Biologischen Zentralanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, H. 79, 1954.

Steudel, W., and G. Schumacher:
Die Vergilbungskrankheit der Zuckerrübe. (Yellows of sugar beets.)
Landw. Zeitschr. d. Nordrhein-Provinz. 120, 1953, 509.

Unterstenhöfer, G.:
Neue Entwicklungsmöglichkeiten in der Blattlausbekämpfung mit chemischen Mitteln. (New development possibilities for controlling aphids with chemical preparations.)
Zeitschr. f. Pflanzenkrankheiten 58, 1951, 268—275.

—
Über das innertherapeutische Insektizid "Systox".
(The systemic insecticide "Systox".)
Med. Landbowhoogeschool. Gent 17. 1952, 75—87.

Watson, M. A., and D. J. Watson:
The effect of infection with beet yellows and beet mosaic viruses on the carbohydrate content of sugar-beet leaves and on translocation.
Ann. of Appl. Biol. 38, 1951, 276—288.

Watson, M. A., and R. Hull, J. W. Blencowe, B. H. G. Hamlyn:
The spread of beet yellows and beet mosaic viruses in the sugar beet root crops. I. Field observation of the virus diseases of sugar-beet and their vectors *Mycus persicae* and *Aphis fabae*.
Ann. of Appl. Biol. 38, 1951, 743—764.

Watson, D. J., and Watson, M. A.:
Comparative physiological studies on the growth of field crops.
III. The effect of infection with beet yellows and beet mosaic viruses of the growth and yield of the sugar-beet root crop.
Ann. of Appl. Biol. 40, 1953, 1—37.

Wenzl, H.:
Die Bekämpfung der Vergilbungskrankheit der Rübe. (The control of yellows on beets.)
Der Pflanzenarzt 1953, 4, 2—7.

—
Die räumliche Auswirkung von Infektionszentren der Vergilbungskrankheit der Rübe. (The spatial effect of infection centres of yellows on beets.)
Pflanzenschutzberichte, 10, 1953, 97—111.